0   How to Read This Manual

The Radosys track analysis system is dedicated to all laboratories, which intends
- to start-up a radon test service or research by PADC/CR-39 technology or
- to start up neutron dosimetry service or research by PADC/CR-39 technology
or
- to update its existing CR-39 lab practice to a leading-edge technology or
- to extend its lab practice by the features of the PADC/CR-39 technology or
- to replace its current radioprotection technology to a PADC/CR-39 based one

Since the first launch of the first Radosys version in 1998, the users of the system started their application from various platforms of knowledge about radioprotection, radon and general dosimetry related issues. A part of them just wanted an application oriented tool with a recipe about how to process a dosimeter service by step-by-step instructions. Other users were interested in also the operational details for research applications as well.

This Manual has been constructed with the concept to meet the demands and interests by all kind of potential or existing users of the Radosys system. During composing this Manual we paid a great attention on that to find a suitable structure of documentation, which might make it efficient for all the Radosys users regardless their level of interest about routine operation or engineering details.

This Manual contains a huge amount of information and guidance about the usage of the system. But please do not worry about the size of this Manual. The routine application of the system is far not as complicated as the size of the Manual may suggest it at the first sight. The reason of those many pages in the Manual is that we intended to equip this also with step-by-step instructions. Moreover many chapters are included just for advanced operation. Nevertheless, because of trying to be detailed as much as possible, the information may be redundant at certain chapters and cross-references.

In order to find the most relevant information according to your interest, we suggest a sequence of reading of Chapters to learn the usage of the system efficiently.

0.1   NEW USER WHO IS LOOKING FOR APPLICATION ORIENTED STEP-BY-STEP RECIPE.

Read the following Chapters
Chapter 3. <Overview of the radon measurement process>
Chapter 4.2.3. <RB4 Etching Unit Standard Operation>
Chapter 4.5. <Routine operation with the Radosys RS-RM Version Track Analysis Software>
Chapter 4.7.1. <Routine Operation With DMU-99 Version Software>

0.2 NEW USER FOR APPLICATION RECIPE AND FOR SCIENTIFIC INFORMATION

Read the following Chapters
Chapters listed in section 0.1.
Chapter 2. <Overview of the Radosys Detectors>
Chapter 6. < System Metrology Performance Information >
Chapter 7.6.2.3. < The principle of the Statistically Stable Track Reading Approach >

0.3 ADVANCED USER TO OPTIMIZE THE EXISTING RADOSYS LAB PRACTICE

Read the following Chapters
Chapters listed in section 0.2.
Chapter 5. <Advanced Operation>

0.4 ADVANCED USER TO FIND SYSTEM SERVICE/MAINTENANCE INFORMATION

Read the following Chapters
Chapters listed in section 0.3.
Chapter 7. <Radosys System Engineering Details>
Chapter 9. <Maintenance and Troubleshooting>

0.5 N-DOSYS USERS FOR INFORMATION ABOUT NEUTRON DOSIMETRY APPLICATION

Read the following Chapters
Chapters listed in section 0.3.
Chapter 7.9. <Scientific Background of the N-DOSYS Neutron Dosimeter Application>
Chapter 2.4. <RSNS Type Dosimeter>
Chapter 4.8. < N-DOSYS, Neutron Dosimetry Application Specific Proceduer>

1   Introduction to the Radosys system

Thousands of radon tests are conducted all over the world in a single week. The radon is the most significant naturally occurring radioactive source in the living environment. Its existence is quite independent from the industrial activity as well as from the application of the nuclear power. The potential health risk of the radon existed even at the ancient time of the history, just this had been unknown until its discovery at the middle of the '80s.

Nowadays hundreds of health care organizations and home inspection companies conducts radon tests in dwellings, workplaces and schools regularly in order to locate the living sites with high radon risk. In many countries every new house is required to incorporate some degree of radon preventive measures at the time of construction in accordance with the governmental regulation.

Our product concept is that we offer the user a system which includes all of the components that is needed for conducting a radon survey. All of the components, from the detector through the etching unit even to the automated track reader instrumentation. Moreover, exact calibration data is supplied together with our radon detectors.

The usage of the system does not need any additional research. As the system is installed it is applicable for radon test instantly. The routine usage of the system does not need a skilled person, it is easy to use and step by step instruction manual helps the training. The consumed components, that are the CR-39 detector, exposure pot and detector holder, are supplied by the manufacturer at an in-stock basis.

Thanks to the CR-39 technology, the RadoSys offers the customer the capability of conducting big volume tests. This makes the RadoSys distinguished from any in-situ device, the latter requires the placement of the equipment to the test site for a prolonged time. Contrary, at the case of the RadoSys, the customer uses a central laboratory evaluation unit and the on-field data collection is carried out by means of a big quantity of low-cost detector devices. The number of the on-field detectors may exceed the number of 10,000 pieces at the same time. Therefore, a radon survey may provide individual data for each test site, and not just a sampling value extrapolated for a big field area.

The customer owns the full range of tools for a radon survey. It does not need any external service provider for the evaluation of the test detectors.

Concerning the level of the initial investment, that is needed to own the full forth of a Radosys, the most expensive component is the RadoMeter automatic track-evaluating microscope. However we are in the position that we can offer our product solution at a price that is much far below the current market average. The secret of this that we are developing an other product line with a similar image analyzer belonging to the area of

medical electronics, and the joint manufacture condition permits us to keep the manufacture cost of the RadoMeter microscope at low level.

1.1   THE ADVANTAGE OF THE CR-39

The CR-39 technology provides the opportunity of conducting Radon Activity Concentration (RAC) test at many thousands of sites at the same time.

This also provides time integral RAC value, therefore any short-term variation of the local RAC value can not provide misleading result. At the radon test of a site, the study of the integral RAC value is relevant, since this provides information about the irradiation load of the personals living at the site to be tested.

The detector itself, that is placed to the site to be tested for two-three months, is inexpensive, therefore the management of the detectors does not need any particular security consideration. Contrary the usage of any expensive test device would need this consideration at the test site.

1.2   OVERVIEW OF THE RADOSYS CONCEPT

It is a fundamental concept of the RadoSys, that the product comprises all of the components and tools, that is necessary to conduct series of radon activity concentration measurement regularly. Nevertheless the system offers the feature of the large-scale radon survey. The user can run many thousands of measurement at the same time, and after taking the test detectors back to the user's laboratory, the evaluation and the RAC data is provided quickly, thanks to the large capacity etching unit and to the full automated track evaluation image analyzer microscope. The user can carry out the whole process without any assistance either of other laboratories or of the manufacturer. As a result of the measure process, the user get a calibrated RAC data.

During the development of the RadoSys, the engineers paid a big attention to the safety of the user. Concerning the safety, the only critical step is the etching of the detectors. Since at this step the user have to treat dense sodium-hydroxide, this step of the process needs some particular consideration. The process of the etching step and the structure of the RadoBath etching unit was designed to prevent the user from any direct contact with this dangerous material. Following the instruction of the user manual makes this etching step extremely safe.

The only component, that are needed for the test process and are not provided by the manufacturer of the RadoSys, these are a few sort of fine chemicals for the detector etching step. However these chemicals are widely available at fine chemical material suppliers, no any particularity with this materials.

2   Overview of the Radosys detectors

Various types of detectors for indoor radon tests and for special applications are available.

2.1   RSFS TYPE DETECTORS

This type of radon detector was the standard type in the Radosys's detector production program until 2005. In the Radosys production program the RSF type was replaced by the RSKS type detector, which latter provides a good replacement with even better application performance. The RSF type is no longer available to buy, but it has become component of the Raduet type detector.

Detector Specification

Application Area: Indoor Radon Test
Also Workplace Application with Notice:
There is No any Built-In Working Hours Control Feature
Scope of Lab Practice: Routine Analysis
Meets the requirements for Lab Accreditation
Typical Time of Exposure: 3 months. Can be extended to 6 months
      Applicable also for short term test of 20 days, with precaution about the excess imprecision occurring at short term tests.
Overall System Imprecision Utilizing RSFS Radon Detector:
15% for test region from 150 to 2000 kBq.h.m-3
Alpha Particle Detecting Substance: PADC/CR-39 Plastics
Diffusion Chamber Concept: Air-Gap Filter
                                      Tamper Proof
                                      Robust structure with extra Crash protection
Electro-Static Protection: Diffusion Chamber Made of Conductive Plastics
                                      Detecting Substance Pre-Treated by Dipping
CR-39 Chip Size;   100 mm2
Typical Equilibrium Time: 3 hours
Typical Sensitivity: 2.4 tracks.cm2.kBq-1.h-1.m3
Typical Initial Background   0.3 tracks.mm-2
Saturation Limit   greater than 12000 kBqh/m3
      Note: Subtype RSFV with saturation limit of 100000 kBqh/m3

Standard Packaging Features:
– Custom Designed Label Service is Included
– Fully assembled detectors in airtight pouch with Al-vapor finish.
– Each detector is sealed into airtight/radon proof pouch in N2 atmosphere individually.
– Pouch is equipped with external detector ID label, with customized, two-color label.
– Pouch is equipped with V-like edge cutting section to open easily.
– Bar code on the external label is also available feature.
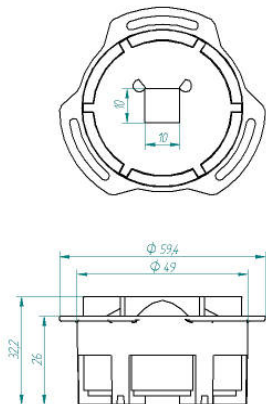
RSF Type Diffusion Chamber. A Layout Drawing and a Panoramic View.
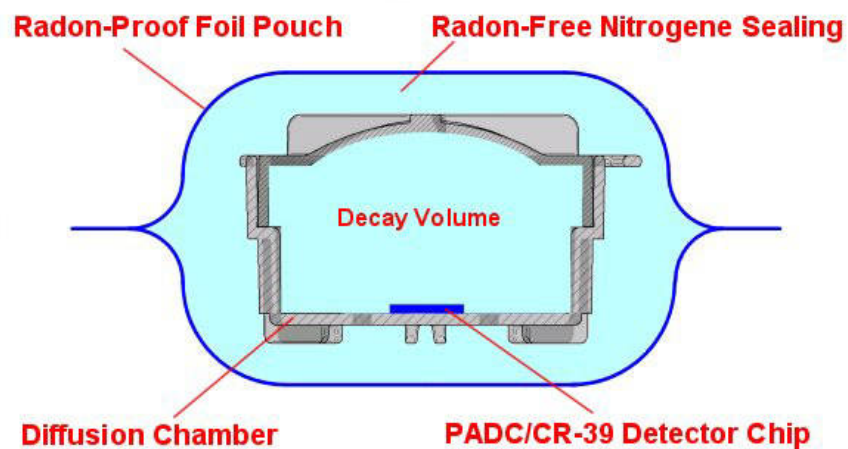
The structure of the RSFS type, ready-made detector.

Chapter 2.   **Overview of the Radosys detectors**

2.2   RSFV TYPE DETECTORS

This is a subtype of the standard RSFS detector.

Components of RSFV Type Detector

Primary Diffusion Chamber

Secondary Diffusion Chamber

Primary Decay Volume

Primary Detector Chip

Secondary Detector Chip

Secondary Decay Volume

The structure of the RSFV Type detector.

The highlighted feature of this type is that the saturation limit is extended to 100000 kBq.h.m-3. Its principle of operation is based on the Radosys's double chamber technology.

It consists of two detector chips and two diffusion chambers; one detector chip for each chamber.

The main detector chip works with the main RSF type diffusion chamber. The secondary chip works with a secondary diffusion chamber, which decay volume is much smaller than that of the main chamber. The main chamber performs higher sensitivity, which is similar to that of the standard RSFS type. But the secondary chamber together the secondary chip performs much lower sensitivity, providing significantly extended limit of saturation.

Whenever the main chip goes to saturation, the secondary chip provides the radon activity concentration result.

This detector type is suitable for applications, where the radon activity is unpredictable before the test. Utilizing the RSFV detector may spare a repeated test, actually the time of 3..6 months.

This is dedicated for application, where extreme activity levels used to happen, for instance at tests in soil.

2.3   RADUET TYPE DETECTORS

This is a subtype of the standard RSFS detector.
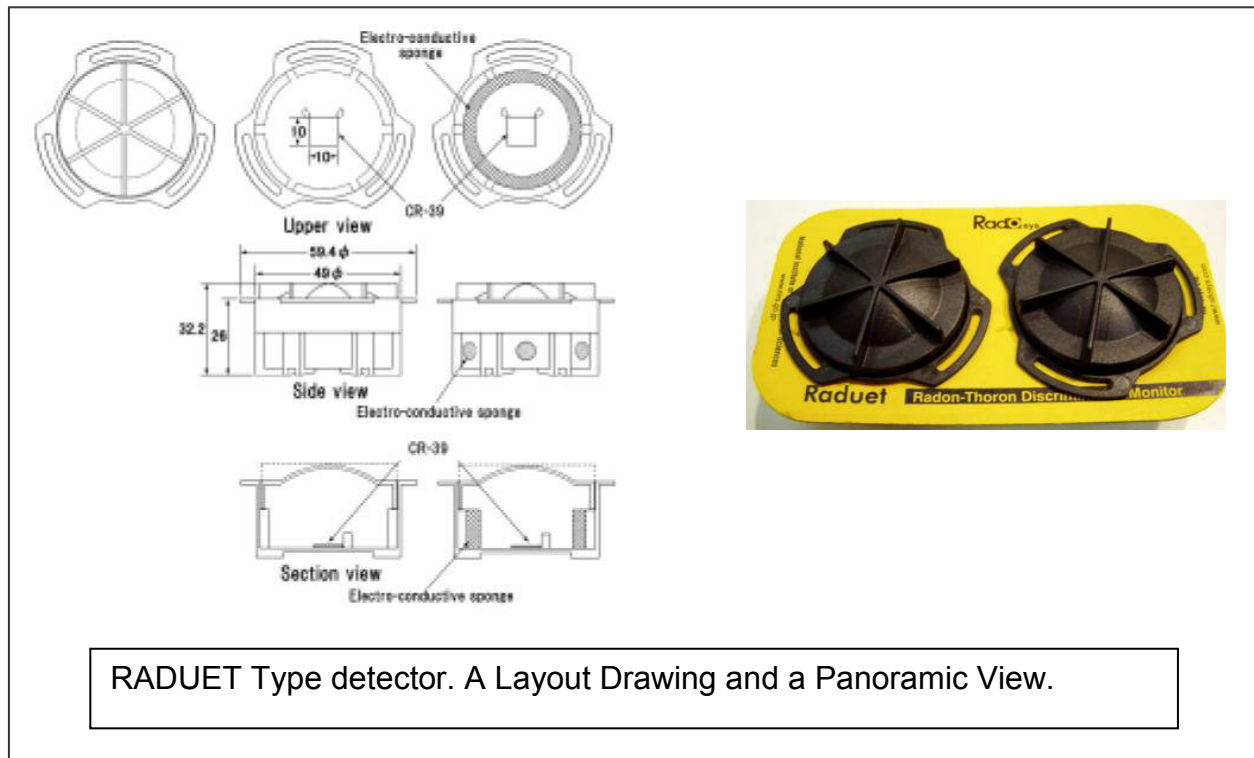
RADUET Type detector. A Layout Drawing and a Panoramic View.

This detector type is dedicated to combination detection of radon and thoron activity at the same time.

It consists of two detectors – a standard RSF type detector and a modified version, the latter with reduced response time. The main chamber is selective for the radon activity primarily. But the secondary chamber is sensitive for both radon and thoron. A simple linear calculation separates the radon and thoron activity data results.

The RADUET type detector is a result of collaborative work of NIRS, Japan and of Radosys Ltd.

The core reference in this respect is as follows.

"Radon-Thoron Discriminative Monitor" means: A newly designed alpha-track detector for discriminatively determining radon and thoron concentrations. A prototype of the device is based on that in the article entitled A simple passive monitor for integrating measurements of indoor thoron concentrations, published by Weihai Zhuo, Shinji Tokonami, Hidenori Yonehara and Yuji Yamada NIRS in Review of Scientific Instruments, Vol. 73(8):2877-2881; 2002. Other, more comprehensive article from the same authors:

"Up-to-date radon-thoron discriminative detector for a large scale survey" by Shinji Tokonami, Hiroyuki Takahashi, Yosuke Kobayashi, Weihai Zhuo and Erik Hulber in Review of Scientific Instruments, Vol. 76: 3505-3509, 2005.

2.4   RSNS TYPE DOSIMETER

The RSNS type dosimeter is dedicated to individual fast neutron dosimetry, monitoring radiation workers in environment and workplaces, where elevated level of doses from fast neutrons is expected.

PP /2mm
HDPE /1mm
PA-6 /1mm
CR-39 /1mm
CR-39 /1mm
HDPE /1mm
PA-6 /1mm
PP /2mm

Structure of the RSNS type dosimeter

Abbreviations:
HDPE - High Density Polyethylene
PA – Polyamide
PP – Polypropylene

The PA converters in the badge are marked by blue spots.
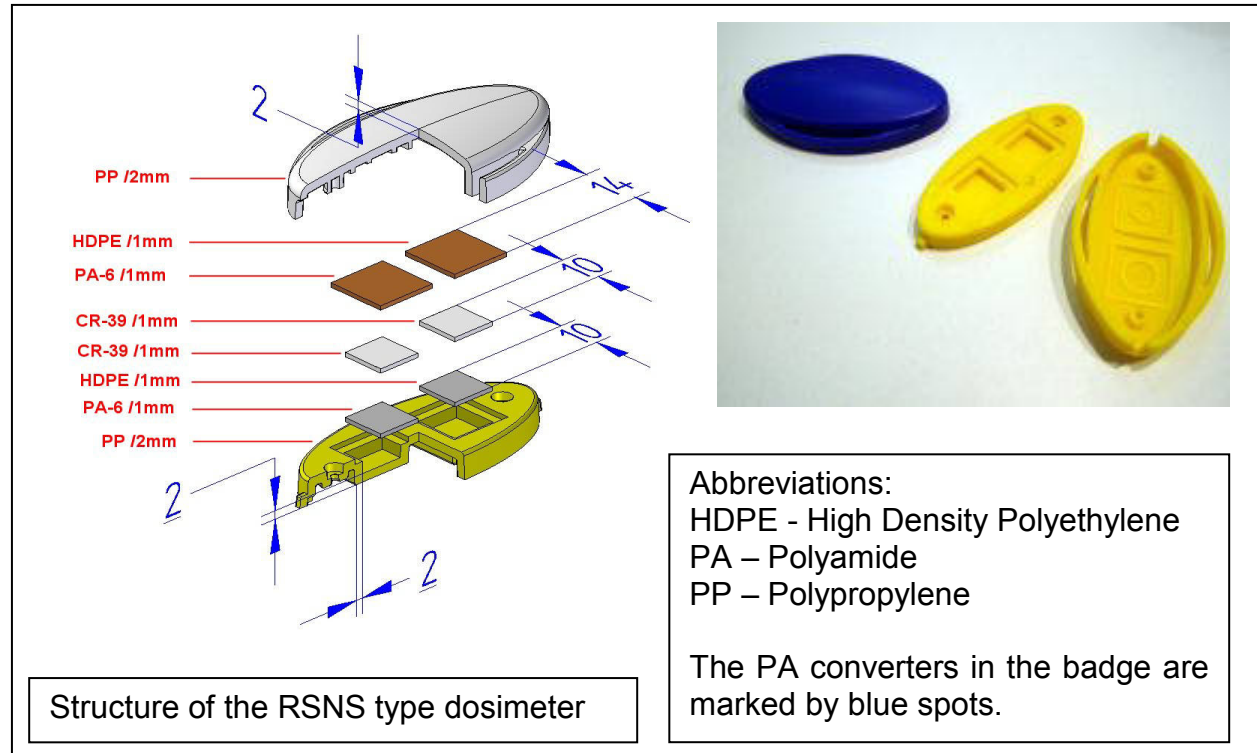
The RSNS dosimeter consists of two separate dose measurement sections.

One of them works with polyethylene converters, which is dedicated to the fast neutron energy region. This is conventional way of counting fast neutron flux by CR-39 material. Therefore this section is the main channel in the application of the RSNS dosimeter.

The second section works with polyamide (Nylon-6) converter. This type of converter material is more sensitive for the epithermal energy region of neutrons, than the channel of the PE converter. This approach can be considered less conventional, but this is applied also by a few dosimeter service laboratories. At the RSNS dosimeters, this channel is less characterized at the date of issuing this Manual. Therefore this channel can be considered as added for the purpose of research applications.

The badge is just a holder of the PADC chips and converters. This is made of polypropylene plastics, which is neutral concerning to this application. No any relevant reaction with fast neutrons is occurred in it, so its contribution to the measured dose result is negligible. The badge is equipped with handles providing fixing it easy.

2.5   RSKS TYPE DOSIMETER

This type of radon detector is the standard type in the Radosys's detector production program.
This type is a replacement for the former RSFS type detector.

Its advantage as compared to the RSFS type:
- Reduced size with max dimension of 1 inch, providing advantage at cost of service delivery by standard mail in many countries.
- Improved background value because of its improved geometry and of eliminating extra packaging components. Now the background value of the RSKS detector is in the range of the performance of the bare Radosys PADC/CR-39 detector chips, which latter provides one of the best quality for radon detectors on the global market today.
- The opening mechanism of the RSKS detector is very friendly. No any special tool is needed. This can be dismantled by rather standard pliers.
- Its geometry provides larger area for customized labels with more textual information and images.

Detector Specification

Application Area: Indoor Radon Test
Also Workplace Application with Notice:
There is No any Built-In Working Hours Control Feature
Scope of Lab Practice: Routine Analysis
Meets the requirements for Lab Accreditation/Approval
Typical Time of Exposure: 3 months. Can be extended to 6 months
          Applicable also for short term test of 20 days, with precaution about the excess imprecision occurring at short term tests.
Overall System Imprecision Utilizing RSFS Radon Detector:
15% for test region from 150 to 2000 kBq.h.m-3
Alpha Particle Detecting Substance: PADC/CR-39 Plastics
Diffusion Chamber Concept: Air-Gap Filter
                                Tamper Proof
                                Robust structure with extra crash protection
Electro-Static Protection: Diffusion Chamber Made of Conductive Plastics
                                Detecting Substance Pre-Treated by Dipping
CR-39 Chip Size;   100 mm2
Typical Equilibrium Time: 3 hours
Typical Sensitivity: 2.0 tracks.cm2.kBq-1.h-1.m3
Typical Initial Background   0.3 tracks.mm-2
Saturation Limit   greater than 12000 kBqh/m3
          Note: Subtype RSFV with saturation limit of 100000 kBqh/m3 is also available

Standard Packaging Features:
– Custom Designed Label Service is Included
– Fully assembled detectors in airtight pouch with Al-vapor finish.

Chapter 2. _____ **Overview of the Radosys detectors**

– Each detector is sealed into airtight/radon proof pouch in N2 atmosphere individually.
– Pouch is equipped with external detector ID label, with customized, two-color label.
– Pouch is equipped with V-like edge cutting section to open easily.
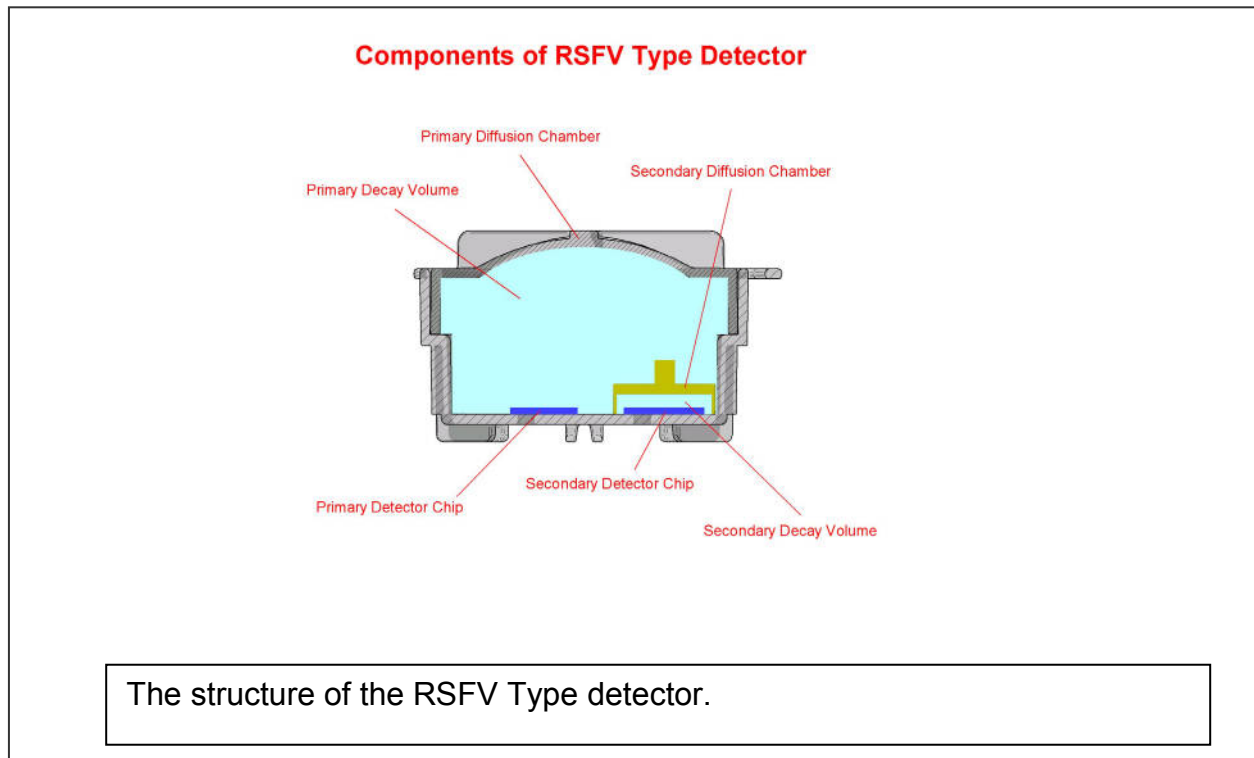– Bar code on the external label is also available feature.

RSK Type Diffusion Chamber. Dimensions and Panoramic Views.
Illustration for customized labels is also shown.

3   Overview of the radon measurement process

3.1   THE WHOLE PROCESS IN GENERAL VIEW

RADOSYS Operation With Large Scale Preview

Detector to the Building

Exposure time from 3 to 6 months

Development in the Lab

Microscopic Analysis

Result Chart

The main sequence of indoor radon test process by the Radosys system.
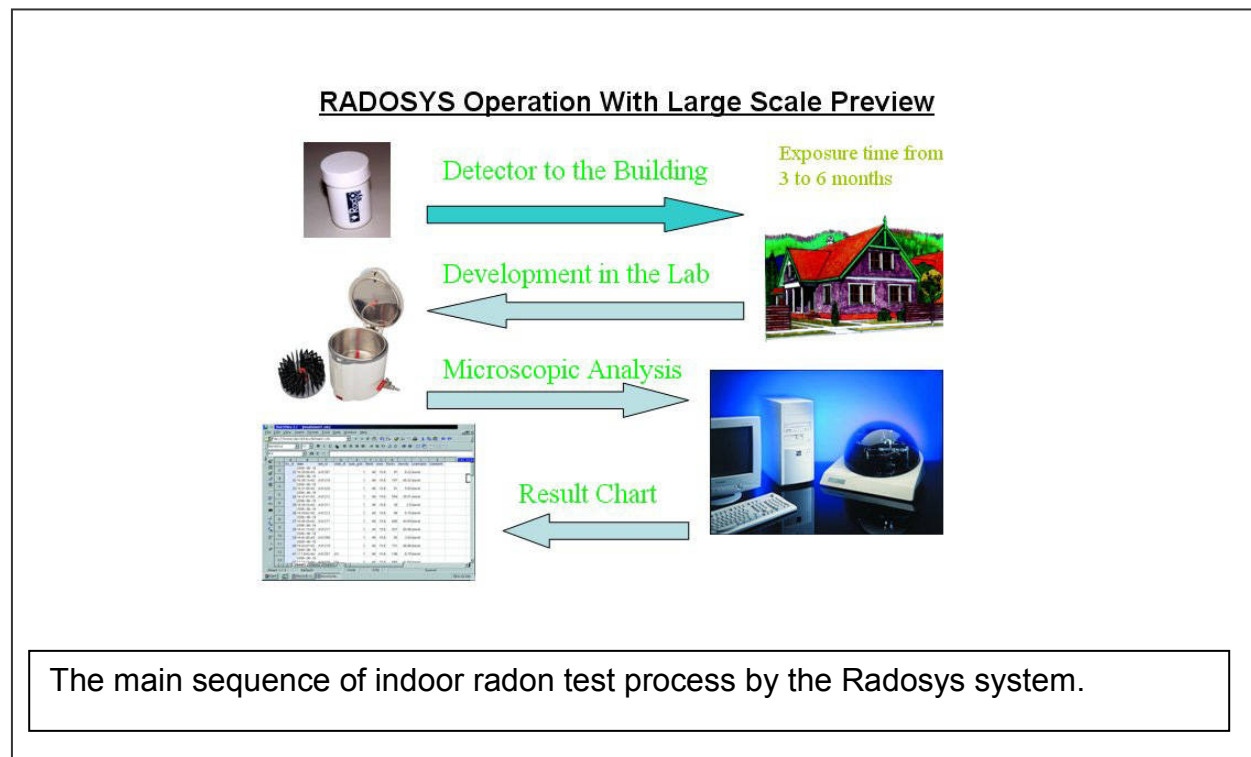
3.2   EXPOSURE

The assembled test detector can be placed to the site to be tested. It should be stay there 2..3 months. The RadoSys default calibration requires 80 days exposure time. After this time the test detector should be taken back to the laboratory for evaluation.

3.3   PREPARATION OF DETECTORS FOR EVALUATION

In order to prepare the detector plastic pieces for etching, these should be dismounted out of the RadoPot and should be mounted to the Radoslide accessory tool. The RadoSlide is a plastic holder, with 12 nests for 12 detector pieces providing perfect matching and fixing. The RadoSlide accessory is delivered with the RadoSet package. To finish the preparation for the etching, the slides with detectors should be placed onto the etching carousel. 36 slides can be placed on the etching carousel maximum. The etching carousel is a part of the RadoBath unit. The RadoSlide accessory is useful also as a long-term storage tool after the evaluation helping any repeated evaluation later.

3.4   ETCHING PROCESS

As a first step of the etching, the user should prepare the etching bath. After the insertion of the stirrer accessory and closing the door of the RadoBath the user fills the components of the etching bath into the RadoBath through a filler hole on the top of the

enclosure unit. The components of the bath are distillated water and solid sodium-hydroxide. The process of solution is exothermal generating harmful vapors, however the compact structure of the RadoBath prevents the user against this vaporization. As soon as the solution process finished, the user can exchange the stirrer accessory to the etching drum by a caliper accessory. The etching carousel fed by slides and detectors should be inserted into the etching chamber of the RadoBath unit. The etching process takes 4 hours. Than the etching solution can be drained, and a neutralizing solution should be filled into the etching chamber. Draining the neutralizing solution and taking the etching drum off, it should be stay to rinse and dry.

3.5   ANALYSIS

Removing the slides with detectors from the etching carousel, these should be inserted to the RadoMeter automated microscope. The RadoMeter evaluates the detectors and provides the RAC data either by printing or in data file format.

3.6   SYSTEM CALIBRATION CHECK

For the safety of the accuracy of the long-term operation, the calibration check of the measure system should be done from time to time. It can be carried out by means of the RadoCal calibration package. Processing the detectors with known RAC value of the RadoCal, the calibration check can be done efficiently.

4   Routine operation

4.1   BEFORE EXPOSURE.   HOW TO USE RADOSYS RADON DETECTORS.

All types of Radosys radon test detectors are ready-made types. These are delivered in fully assembled form and are sealed into radon-proof foil pouch.

The detector is activated by removing the foil pouch. At the moment when the pouch is removed the exposure period starts.

Recommendation for the usage of the detectors:

Before the detector is sent to the site to be tested, record the ID code number on the pouch and assign it to a site identification data. On the external label of the pouch the alphanumeric ID code is accompanied with standard bar code, which latter provides option of scanning it by means of a bar code reader device.

Instruct the person deploying the detector on the site, as follows:

- Remove the foil pouch, when the detector is placed to the site to be tested.
- No any additional action or switching on step is needed. The detector is activated by removing the foil pouch. There is a pre-cut on the open edge of the pouch helping at tearing the pouch up easy.
- After the recommended time of exposure, 3 months, record the date and send the detector back to the service provider company for evaluation. The best practice is when the detector is posted immediately.
- Request sending information about the start and end date of exposure.

How and where to place the detectors in the room to be tested.

There is no any particular or specific suggestion about how and where to place the radon detector. The actual way depends on the preference and practice of the test service company. However a few examples can be mentioned.

- The most popular way is when the detector is simply placed onto book shelf or flower shelf.
- It can be attached under a table using double face tape. Top-down position does not influence on the result. Any orientation of the container works equally. But when the container is fixed by a tape, use the rear of the container. Do not cover the cap side of the chamber, actually where the air-gap takes place.
- It can be placed hanging from the ceiling by a string. If this mode is preferred an inexpensive accessory item is also available for this purpose.

General notes about the application of any AT radon detectors.

Avoid placing the detector close to a heat source, to direct sunlight or anything, which might keep the detector at elevated temperature through a prolonged time. The AT detectors provide the best performance and accuracy at room temperature. Extremely humid environment is also recommended to avoid. For radon tests in humid environments, for instance in spa, caves or workplaces with elevated humidity level, special dedicated type of AT radon detectors are suggested and are available.

More information about the structure and performance of the Radosys radon detectors can be found in Chapter 7, Radosys System Engineering Details.

4.2   AFTER EXPOSURE.   HOW TO USE RADOSYS RADON DETECTORS.

When the exposed detector is returned to the laboratory, this should be dismounted and its sensor component, the PADC/CR-39 chip should be removed and mounted onto the plastic slide accessory.

When it's happened that the returned and exposed detector is needed to store for a while, keep it in radon free environment. Storing on the second floor or outdoor may be a perfect solution, since the radon level on ground floor is always higher. If storing the returned and once activated detectors on ground floor is unavoidable, test the room for radon level and be ensured that the level of radon activity is not elevated there.

The key rule to achieve the best performance of an AT radon test, is the purity of the detector chip treatment. Any dust or impurity or scratches on the CR-39 detector chips may reduce the accuracy and reliability of the result. This requirement does not need any special workplace for the detector handling, just some careful detector handling.

Try to choose a room for dismounting the detector upstairs, since the radon activity is always higher at the ground floor.

Instructions step by step. How to remove the detector chip?

- Dismount the detector canister by separating its lid and pot sections.
At the RSK type diffusion chamber this can be done by rather standard pliers. A very useful type of pliers is delivered by Radosys together with the measurement system.
At the RSF type diffusion chamber a special tool is needed.
- Remove the PADC chip out of the canister by tweezers. Grab the chip on its alphanumeric code area only, in order to avoid making any scratch on the active surface area. The best practice is when plastics tweezers and laboratory textile or latex gloves are used.
- Remove any remainder of the blue adhesive from the chip.
- Mount the detector chip onto the plastic slide holder accessory. This is described in Chapter 4.3.2.4, Preparation of Detectors for the Etching Process.

4.3   DETECTOR ETCHING / TRACK DEVELOPMENT CHEMISTRY PROCESS

4.3.1   OVERVIEW OF RADOSYS ETCHING UNITS

Two different types of etching unit are supplied with the Radosys etched-track analysis system. The **RadoBath 99** version was available between October, 1998 and May, 2005. After May, 2005 the version **RB4** etching unit is available.

The RB4 version is fully compatible with the traditional Radosys application. All the accessory items are interchangeable with the former RadoBath 99 unit. Also the chemistry operation is the same. The RB4 version can be considered as a significantly upgraded version of the former RadoBath 99 unit. The structure of its body is different; it is made of metal and not of plastics, so the RB4 is much more durable. The temperature is regulated by advanced microprocessor technology, contrary to the electro-mechanical type regulator of the RadoBath 99. Thanks to the µP-driven electronics, software features have been also implemented. The whole chemistry process is controllable by means of the front panel keyboard and display. Nevertheless now also the etching time is selectable.

Because of the major similarity between the former version and the RB4 units, in the Chapter 'RB4 Etching Unit Operation', only the version specific issues are documented here. In all other respects read and use the information in the Chapter 'Radobath 99 Standard Operation'.

RB4 Product Version History Information:
Since the time of its first introduction, the RB4 equipment has been delivered with different firmware versions. Before September, 2005 the firmware version FW-1 was implemented in the delivered units, and later on from September, 2005 the firmware version FW-2 was implemented in the delivered equipments. From June 2006 the delivered units were equipped with the firmware version FW-3 and most of the earlier units had been upgraded at the firmware.

4.3.2 RADOBATH 99 STANDARD OPERATION

4.3.2.1 Warnings

The dense sodium-hydroxide, particularly at its hot temperature form is an extremely dangerous material. Any direct contact may cause painful and hazardous health damage. Be careful at handling. However the Radobath process is designed to be safe if you keep the rules. If you are not familiar with handling of chemicals, please consult with a laboratory chemist.

Do not switch on the power of the bath unit at its empty state without any liquid. This may cause damage of the heater and/or the stainless steel bath container.

4.3.2.2 Key accessories at Radobath 99 version Etching Unit

The needed accessories listed here are items to be used through a prolonged time or being consumable items. Some of the constant items are included in the Radobath package, others should be purchased by the user at a local dealer. No any specialty concerning the non-standard items, those are available at any chemistry accessory shop or even at a general household shopping mall. Some of the consumable items can be purchased at fine-chemicals dealer, some of them at rather public shops, at household shops or at petrol station. The only consumable items, that the user should be care of, that are the components of the etching bath, namely the sodium-hydroxide crystal and the high-quality distillated water solvent. The quantity of the consumable items listed here is determined for a single etching process, that is for maximum 432 detectors, which detector quantity is the full load of the Radobath etching unit.

RSBA1,2/ Radobath main unit. This is an electrically powered etching unit included in the Radobath package. This unit requires the availability of an electric power network. The unit is delivered according to the local electric power network standards. Local standard power cord is included.

RSBA3/ Bath mixing motor power adapter. Included in the Radobath package. (Radobath 99 version only)
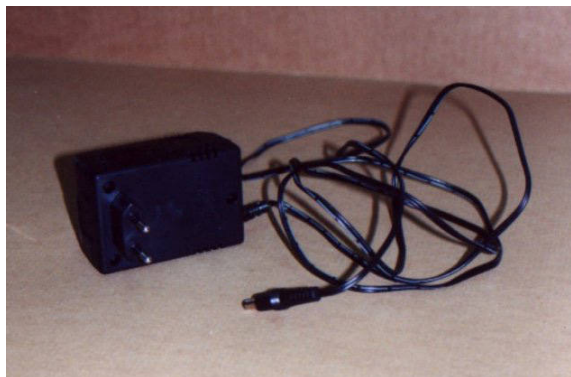
RSBA4/ Bath preparation mixer accessory. Included in the Radobath package.
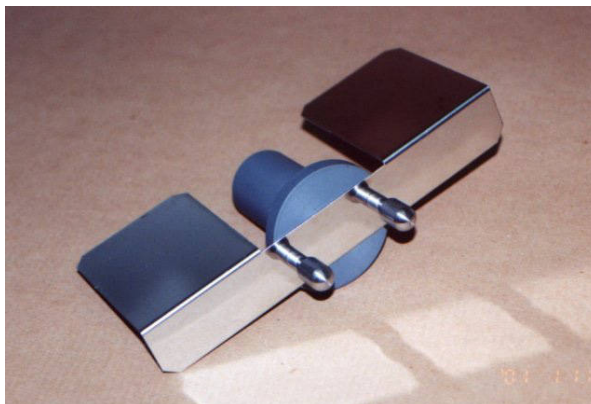
RSBA5/ Etching carousel for fixing the detector holder Slides. Included in the Radobath package.
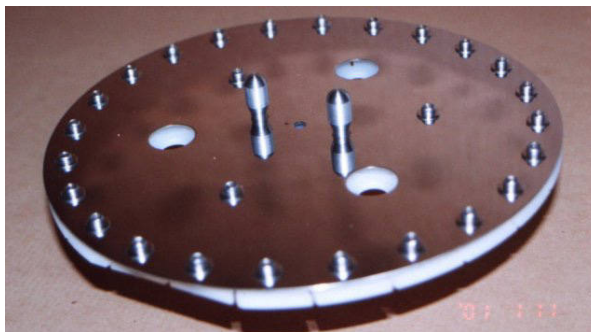
RSBA6/ Lifter / Removal accessory to remove the etching carousel or stirrer out of the bath. Included in the Radobath package.
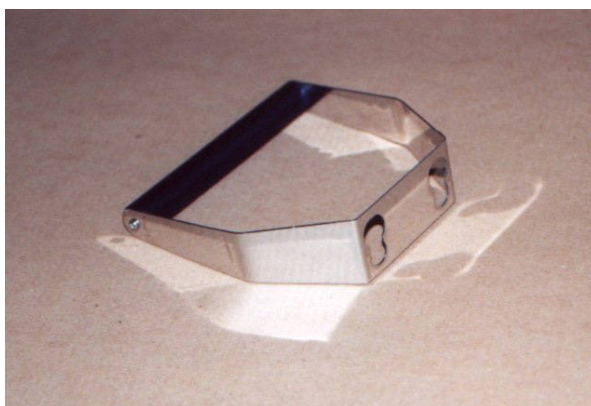
RSBA7/ Funnel for filling liquids and NaOH pellets into the bath. Included in the Radobath package.

RSBA8/ Spatula or spoon for filling the crystal into the bath. Included in the Radobath package.

RSBA9/ 300 ml of 20 v/v% or 400 ml of 15 v/v% vinegar solution with industrial/household grade. Synthetic product is recommended. Available at any shopping mall.

RSBA10/ Laboratory tray for the basement of the main unit. Size should be 400x400 mm or $\varnothing$350 mm at least. Prevents the desk against basin pollution. This can be made of plastic or stainless steel. Should be purchased by the user.

RSBA11/ Laboratory tray for storage of basin contaminated items, that are bath mixer accessory, rod thermometer, or mixer removal accessory. Size should be 400x400 mm or $\varnothing$350 mm at least. Should be purchased by the user.

RSBA12/ Rod thermometer. This is an optional item for checking the temperature of the bath. Not a requirement, however recommended for the control of the proper operation. Should be purchased by the user. Temperature range up to 100 °C, length 300mm at least, no relevant restriction about diameter. Diameter can not exceed 20 mm.

Chapter 4. _____   **Routine operation**

RSBA13/ 1000 g of crystalline sodium-hydroxide with Puriss-Anal quality for the etching bath. Available at any fine-chemical dealer. The size of the granulates (pellets) can not exceed the 10 mm. The size of the granulate is limited by the diameter of the filling funnel.

RSBA14/ 4000 ml of finely distillated water for the etching bath. The puris-anal quality is not a requirement, it does not worth to apply this expensive sort of chemical water. However the application of the water produced by a real distillation machine is highly recommended to achieve the optimal performance. The application of any industrial quality purified water, that is ion-exchanged or reverse-osmotic purified water should be avoided.

RSBA15/ 8000 ml of industrial grade purified water. It can be either ion-exchanged or reverse-osmotic purified water. Available at any drug store or petrol station.

RSBA16/ Cotton gloves for detector treatment.

RSBA17/ Latex gloves for safe chemical treatment.

RSBA18/ Eye-wash stand for health security at the case of emergency.

RSBA19/ A roll of paper-towel for security cleansing.

RSBA20/ 20 l plastic bag for basin contaminated item waste disposal at the case of emergency.

RSBA21/ 4000 ml of 20 v/v% vinegar solution or 20,000 ml of tap water for waste basin disposal. Please check the secure basin dilution rate at your local environment protection standard. Synthetic product is recommended for the vinegar solution.

RSBA22/ 4000 ml of plastic container for the temporal storage of the neutralized basin waste solution.

RSBA23/ 4000 ml or two 2000 ml of high-temperature laboratory bottle for the drainage and storage of the hot etching bath. Nominal temperature of 150 °C is recommended for the bottle. Adding a pouring ring is also recommended.

4.3.2.3 Preparation of the etching unit for the etching process

Please find the details in the chapter " Installation procedure of the RadoBath Etching Unit"

4.3.2.4 Preparation of the detectors for the etching process

By the time of the etching process the on-field detectors, that are the radon sensitive plastic pieces inside the Radopot exposure canister, have been taken to the laboratory from the site to be tested. Remove the plastic chips from the exposure chamber and place them to the RadoSlide detector holder unit. Use cotton gloves for the handle of the detector chips, in order to avoid any unwanted contamination of the etching solution.

Place each detector chip into each nest of the black detector holder accessory, the RadoSlide, which is applicable for twelve detector chips at the same time. The firm insertion is accompanied with a soft click noise, so indicating its light mechanical fixing.

Please care of the proper orientation of the chips.

The engraved codes should be faced upward, therefore the active surface of the chip should face downward considering the proper orientation as a basic requirement considering the automatic code reading.

The alphanumeric code is engraved at the bottom.

Mount the RadoSlide detector holders filled by the detector pieces to the etching drum. There are series of mounting grooves at the bottom section of the disc of the etching drum. The detector holder also comprises a matching groove. The detector holder can be inserted into the groove of the disc by a firm sliding motion.

Please care of the proper orientation of the detector holder. There is a conic open at one end of the detector holder groove for easy insertion. Use this conic end for proper orientation of the detector holder. The proper orientation ensures that the mechanical force of the bath fluid motion during the etching will push the plastic piece into the direction of its nest and not towards its removal. The improper orientation of the detector holder may cause the plastic piece falling down during the etching.

4.3.2.5 Preparation of the etching bath [of the etching liquid]

Insert the mixer accessory (RSBA4) into the Radobath main unit (RSBA1,2). Close the cover (RSBA2) of the bath unit. Insert the plastic funnel (RSBA7) into the hole on the bath cover. Pour 4000 ml of distillated water into the bath. Switch on the heater as well as the bath revolving motor.

4.3.2.6 The etching process

The heater will arise the temperature of the water gradually. Wait until the temperature of the water is ... controlled by ... thermometer if you want to ... the etching bath. Lift the mixer insertion ... not to damage it by ... the safe place ... the temperature of ... empirical ... time of switching ... the basin contaminated the water ... onto a laboratory tray ... power

Use latex gloves. Open the cover of the etching bath. Lift the mixer insertion accessory (RSBA4) by the removal accessory (RSBA6) and place the mixer onto a laboratory tray

30 minutes at 100V/130V mains power

As soon as the temperature of the water re... eater and start to add the solid sodium-hydroxide granulates t... ld the granulates earlier, since the dissolution rate of the gra... If this rule were neglected, the basin could freeze at the bott... tap, causing an inconvenient stuck at the time of the drain... necessary during adding the granulates, since this kind of chem... one.

The dispensing should be done by the 25 ml plastic spoon (RSBA8) through the plastic funnel (RSBA7). Use latex gloves for safety.
Pour one spoonful of granulates into the bath at every minutes and not frequently. This is a very strict rule. The solution of the solid sodium-hydroxide is an exothermic process generating heat. Any too violent dispensing of the granulates may cause the overheating of the solution with overflow of the fluid. The overflow may cause the damage of the bath unit, even may be harmful for the user as well.
The process of dispensing the full amount of 1000g of sodium-hydroxide granulates takes 40 minutes approximately.

Close the cover of the etching bath. The etching process takes 4.5 hours. The length of this time should be controlled thoroughly. Any shorter or prolonged time of the etching process may cause improper size of the alpha tracks, therefore it should be avoided. After four hours switch off the heater and drain the basin into heat-proof laboratory glass. But do not stop the mixer motor. Mixing the liquid will increase the efficiency also during the neutralization. The basin neutralization step should be started immediately.

Insert the etching drum prepared with the detector holders.

4.3.2.7 Neutralization bath

Prepare a diluted synthetic vinegar solution by adding 200ml of 15% or 20% vinegar into 4000 ml of distillated water. Pour the solution into the bath tank. After a few minutes drain the neutralized fluid into a laboratory plastic container.

4.3.2.8 Final washing bath

Pour 4000ml of washing distillated water into the bath tank. Drain the washing water into a laboratory plastic container.

4.3.2.9 Rinsing and drying

Open the cover door of the etching unit and remove the etching drum. Place it to a laboratory tray for rinsing and drying. After an hour of drying the detector holders with the radon test plastic pieces can be taken for evaluation at the Radometer track evaluation unit.

4.3.2.10   Storage of the chemicals

The hot sodium-hydroxide solution should be stored in heat-proof laboratory glass. The neutralization and final washing water bath can be stored in any plastic container.

4.3.2.11   Waste chemical treatment

Concerning the disposal of the used chemicals, the sodium-hydroxide solution should be treated with extreme attention. It can not be disposed directly because of environmental safety reasons. Two alternative methods can recommended for the disposal. This can be disposed either by neutralization or by proper dilution. One liter of sodium-hydroxide solution can be neutralized by adding four liter 15% vinegar solution. The proper dilution rate in tap water is an other method. Concerning the permitted dilution rate, please consider the local environmental standard or consult a environmental safety engineer.

4.3.3 RB4 ETCHING UNIT STANDARD OPERATION

Read also the Chapter 4.2.1, OVERVIEW OF RADOSYS ETCHING UNITS

Information about firmware versions.
Units with S/N. RB4-104 or higher were supplied with firmware version RB4-FW2 or FW3. The operation for these, 2nd generation, units is documented in the chapter 4.3.2.

The firmware version FW2 was designed to providing full functionality of the Radosys brand RB4 Etching Equipment. The next features are implemented in the FW2 firmware version.
Application oriented series of programs are available, which provides assistance and automatism through the entire process of the detector development. That is through the steps of Etching Liquid Preparation, Main Etching Step, Neutralization Step, and Final Washing Step.
The programs and settings are controlled by means of the front panel keys. The front panel LCD display provides in situ information about the progress of the program.
Timer functions and sound alarms are implemented in order to provide assistance for the exact fulfillment of a Track-Etch detector development recipe.

The firmware versions FW2 and FW3 are almost the same. The only difference that a new feature was added to the FW3.

At units with firmware version FW3, the etching time can be set by the user freely. However this is recommended for research purpose only. The default settings of 4.5 hours is recommended for routine application.

4.3.3.1 Warnings

4.3.3.1.1 Precautionary Measures at Handling Chemicals

The dense sodium-hydroxide, particularly at its hot temperature form is an extremely dangerous material. Any direct contact may cause painful injure. Be careful at handling. However the Radobath process is designed to be safe if you keep the rules. If you are not familiar with handling of chemicals, please consult with a laboratory chemist.
Always use latex gloves to handle chemicals.

4.3.3.1.2 Precautionary Measures at Using the Etching Unit Empty

Do not switch on the heater of the bath unit at its empty state without any liquid. This may cause damage of the heater and/or the stainless steel bath container.

4.3.3.1.3 Pot and Lid Are Matching Parts

The lid and pot sections of each RB4 Etching unit were manufactured as matching parts. The lids are not interchangeable between different RB4 units. The serial numbers are printed on the ID labels located at the rear wall of the lid and pot sections. The matching pairs of Pot and Lid are labeled by matching part numbers, for instance RB4-123-POT and RB4-123-LID.

4.3.3.1.4 Precautionary Measures at Power Network Connection

Always use the RB4 Etching Unit with a power network socket, which has a ground contact. The body of the RB4 unit is made of metal and its operation with grounded power network socket is a requirement. It is strictly prohibited to use it with two-pole electric power sockets. The RB4 unit is delivered with a power plug having ground contact. Only a completely matching socket is permitted to use. The supplier of the system, Radosys Ltd does not admit any responsibility if this strict rule is failed or neglected in any respect.

4.3.3.2 Key Components and Accessories

Read also the Chapter 4.2.2.2, Key accessories at Radobath 99 version Etching Unit

4.3.3.2.1 The Main Components of the RB4 Etching Unit

These pictures below provide explanation for the terminology applied in this text about the parts and components of the RB4 equipment.

The main sections of the RB4 Etching Equipment
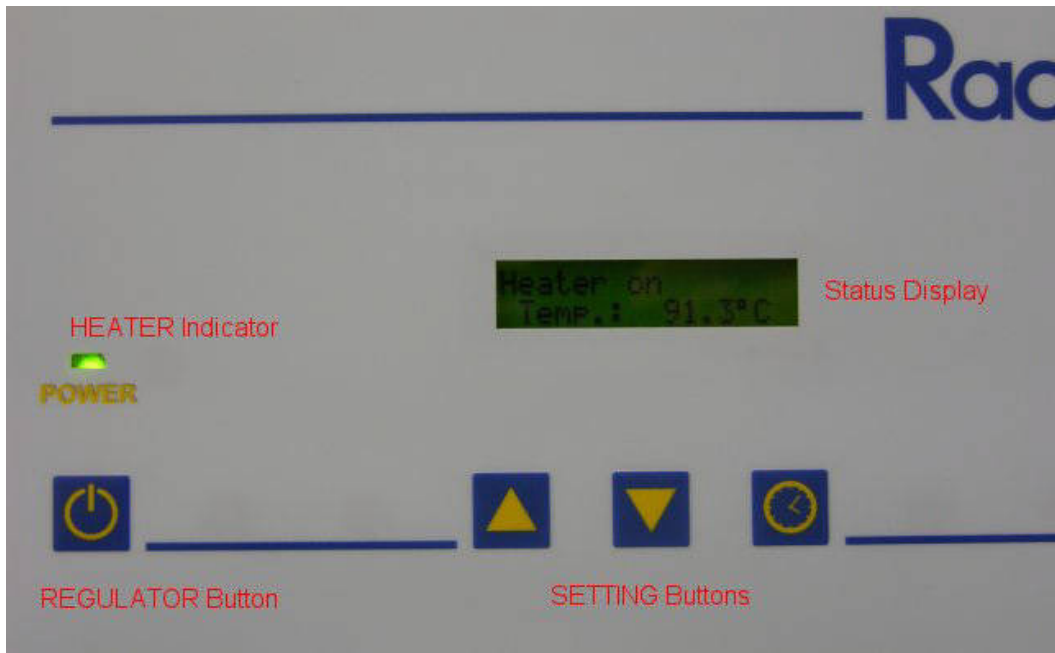
The Front Panel Keyboard

The Status Display

4.3.3.2.2 The Lid Section of the RB4 Etching Bath
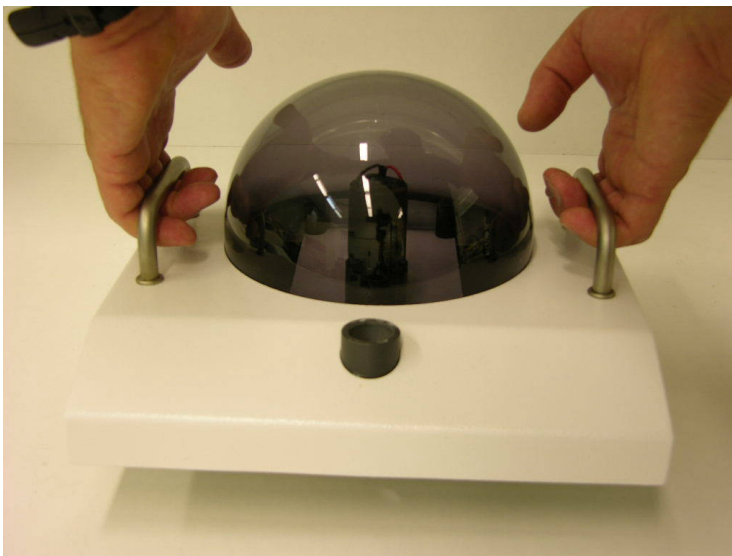
This picture demonstrates the proper handling of the Lid. The lid of the RB4 unit can be removed up from the Pot section by lifting it by its handles. Place it to the Pot section in reverse order.

4.3.3.2.3 The Functional Components of the Lid Section
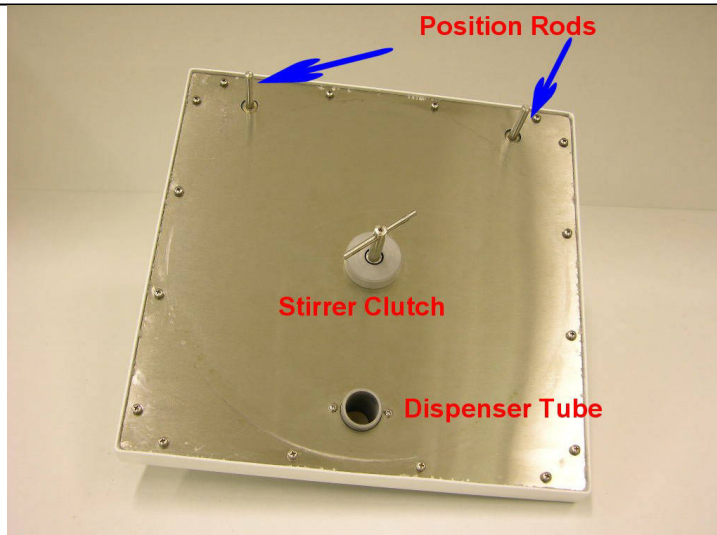
Bottom view of the Lid Section. There are two metal rods at the bottom of the Lid. Their role is two-fold. They assist at the proper positioning of the lid to the pot section. But they also act as an electric wire to power the stirrer motor.
The stirrer clutch has a definite direction of rotation ensuring the proper operation.

4.3.3.2.4 Proper Placement of the Lid to a Desk

> The Lid can be placed to a tray or desk as a three-leg item, by means of its two position rods and the stirrer clutch.

4.3.3.3 Preparation of the etching unit for the etching process

Please find the details in the chapter " Installation of the RB4 Etching Unit"

4.3.3.4 Preparation of detector chips for the etching process

Read the corresponding Chapter 4.2.2.4 in the Section "Routine operation with the RadoBath 99 etching unit".

Warning.
The etching carousel has 24 slots for slides, which makes maximum 36 slides possible to mount on the carousel. The same slides act as stirring the liquid itself. Whenever it is happened that a few or more slots remained empty, please place empty slides also to those positions. This protects the carousel against unbalanced mechanical forces during stirring the liquid. Failing this rule may cause crashing the carousel. Precautionary measures by keeping this rule in mind will lengthen the life of the carousel.

4.3.3.5 Preparation of the etching bath [of the etching liquid]

Remove the Lid of the RB4 unit and place it to a lab tray or to the desk.
Insert the stirrer accessory into the pot of the RB4 unit, than the lid to the pot again. Insert the funnel into the dispenser tube on the top of the lid. Pour 4000 ml of distilled water into the RB4 unit. Replace the funnel with the stopper.

Chose the process program <Solution Preparation>.
(Read Chapter 4.2.3.12. about How To Use the Front Panel Keyboard)

Activate the program by pressing the Heater [button image] button.
Now the water is warmed up to 90 centigrade automatically.
When the water reaches 90 centigrade a sound alarms.
Replace the stopper with the funnel.
Start to dispense the NaOH pellets through the funnel.
Dispense one spoonful pellets at each third minutes. Sound alarms for the next amount of pellets.

After each dispense action acknowledge it by pressing an up/down button [button image] .
When all the 1000g NaOH pellets dispensed to the bath, go to the next step, "The Etching Process".

Warning
The proper periodicity of dispensing the pellets is important rule in order to avoid over-boiling the solution. The solution process of NaOH pellets in water is exothermic, which generates excess heat. If the proper periodicity fails, this may cause over-boiling the solution out of the pot.

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4.3.3.6 The Etching Process

Remove the Lid and place it to a lab tray or to the desk.
Use latex gloves for your safety. Lift the stirrer accessory by the removal/lifter accessory and place the basin contaminated mixer onto a laboratory tray.

Insert the etching carousel into the pot. The slides with detectors has been mounted to the carousel before inserting to the pot.

Place the Lid to its normal position on the pot section of the etching equipment.
Chose the process program <Etching>.
(Read Chapter 4.2.3.12. about How To Use the Front Panel Keyboard)

Activate the program by pressing the Heater [button icon] button.

The insertion of the carousel with many slides may cause dropping the temperature below 90 centigrade. If this happens, the control logics starts a short Warming Up period of a few minutes. This is indicated on the Status Display. When the temperature reaches 90 centigrade again, a sound alarms. Acknowledge this condition by pressing one of the up/down buttons.

If the insertion of the carousel does not change the temperature, the short Warming Up period is missing and the etching period starts instantly.

The start of the etching period is informed by the next content of the Status Display.

Etching
27.8°C   0 01 17

> The countdown timer and the information <Temp. Holding> are displayed alternatively.

The etching time takes 4.5 hours [default value]. The displayed countdown timer informs about the remaining time.
Now you may leave the RB4 unit alone safely.

After 4.5 hours a sound alarms. The etching has been completed. The heater is switched off automatically by the control logics.

Drain the etching solution into a heat-proof laboratory glass, or more glasses. Do not forget to close the drain tap after draining.

Acknowledge this condition by pressing one of the up/down buttons and go to the next step "Neutralization". The Neutralization step should follow the etching immediately.

Note
The default etching time of the Radosys etching recipe is 4.5 hours. However the etching time is a selectable option in the Settings program menu of the RB4 unit.
But to keep compatibility with the whole application, do not change this default timing value. Use this option only for research purpose.

4.3.3.7 The Neutralization Bath
Prepare a diluted synthetic vinegar solution by adding 200ml of 15% or 20% vinegar into 4000 ml of distillated water. Or alternatively, use an equivalent light acidic solution.
Replace the stopper with the funnel.
Pour the solution into the bath tank.

Chose the process program <Neutralization>.
(Read Chapter 4.2.3.12. about How To Use the Front Panel Keyboard)

Activate the program by pressing the Heater [⏻] button.

The neutralization process takes 10 minutes. During neutralization the control logics keeps the heater off.

Sound alarms about the completion of the neutralization.

Drain the neutralizing solution into plastic lab container.
Acknowledge this condition by pressing one of the up/down buttons and go to the next step.

4.3.3.8 The Final Washing Bath

In order to remove any excess chemicals use a final washing bath with distillated water. This step is not programmed in the RB4-FW2/FW3 firmware versions, but this is recommended. In the lack of final washing step, it may happen that unwanted stains remain on the detector chips, which may reduce the accuracy of track counting.

Pour 4000ml of distillated water into the bath tank. Drain the washing water into a laboratory plastic container.

4.3.3.9 Rinsing and Drying

Remove the Lid of the etching unit and remove the etching carousel. Place it to a laboratory tray for rinsing and drying. The best practice is to keep it drying for a few hours or overnight. After drying the detector holders with the radon test plastic chips can be taken for evaluation at the Radometer track evaluation unit.

4.3.3.10   Storage of the chemicals

The hot sodium-hydroxide solution should be stored in heat-proof laboratory glass. The neutralization and final washing water bath can be stored in any plastic container.
Read more in the Chapter 5.6.2 "Chemistry Related Info" in the section "Tips and Tricks".

4.3.3.11   Waste chemical treatment

Concerning the disposal of the used chemicals, the sodium-hydroxide solution should be treated with extreme care. It can not be disposed directly because of environmental safety reasons. Two alternative methods are suggested for the disposal. This can be disposed either by neutralization or by proper dilution. One liter of sodium-hydroxide solution can be neutralized by adding four liter 15% synthetic vinegar solution. The proper dilution rate in tap water is another method. Concerning the permitted dilution rate, please check the local environmental standards or consult with an environment safety engineer. At either case it is firmly recommended to consult with a chemist in order to meet the local safety standards. In many countries professional companies specialized on waste chemical disposal offer matching service. The manufacturer, Radosys Ltd does not keep any responsibility for any misuse of waste chemicals.

4.3.3.12   How to use the Front Panel Keyboard

The RB4 type etching unit is equipped with pre-programmed sequence of the whole etching procedure. The process steps are displayed on the front panel LCD-display and the steps of the procedure can be selected by means of the front panel buttons step by step.

4.3.3.12.1 Available programs for the sequence of the detector development:

Preparation of the etching liquid starts at 90°C
1 min repeated stopper mode

Etching 90°C,
4.5 hours, single-shot countdown

Homogenizing heater OFF
20 min single-shot countdown

User's Settings
Etching time is selectable between 1 min and 24 hours in steps of 1 min
Single-shot countdown or repeated stopper modes are selectable alternatively

4.3.3.12.2 Front Panel Buttons:

	POWER/ HEATER button	Starts or stops the current program. Activates or stops the selected program.
	UP/DOWN buttons	At completion of the current program, push one of these buttons to continue the process sequence with the next step. Acknowledges the completion of the current program. In the Settings program menu, these buttons are used for stepping up/down the target value.
	SELECTION button	Select the next program by this button. This button is available only after completion of a program. Repeated pushing this button will paginate through the available programs.

4.4   DETECTOR EVALUATION / TRACK ANALYSIS PROCESS. GENERAL OVERVIEW

The Radosys track counter software was designed mainly for routine application. This means that the measurement process can be started and completed by easy to follow recipe. In the chapters <Routine operation with…> this recipe is described in the form of step-by-step instructions.

However the software is full of software options. If you use the system the first time, or you do not want to familiarize yourself with other options, just simply use the routine operation recipe. If the recipe followed precisely, the system will provide accurate measurement data. You may need to read the chapters <Advanced operation…> only for research purpose or for troubleshooting.

The Operation of the Radosys evaluation software is based upon the utilization of the LINUX Operational System. General and well known information about the application and the particulars of the LINUX is not presented here. However, the Graphics Interface of LINUX, the X-Windows, today is well similar to that of the Windows, therefore tutorial about the X-Windows is not included in the Manual. Concerning to the advanced topics about LINUX please visit the well-designed help system of the Linux Man Pages and of the KDE Help Center, both are available at your Radosys Computer after start-up.

4.5   MICROSCOPE MODEL SPECIFIC OVERVIEW. MODEL RSV6 VERSUS RSV60

The only difference between the RSV6 and RSV60 microscope models, that the slide management operation is different. The RSV6 model was designed for handling one slide only; that is 12 detectors per each analysis session. This model ensures 20 minutes of continuous operation without any user interaction.

The RSV60 model was designed for handling 24 slides; that is 288 detectors per each analysis session. This model ensures 7 hours of continuous operation without any user interaction.

The RSV60 specific software operation is described in Chapter 4.6.

Engineering details about the slide management is described in Chapter 7.6.

4.6 VERSION OVERVIEW. MODEL RSV6 VERSUS RSV8 AND MODEL RSV60 VERSUS RSV80

The V6 series and V8 series models differ from each others in the optics and the related electronics only.

	RSV6	RSV60	RSV8	RSV80
Auto-Feeder	No	Yes	No	Yes
Image Resolution	VGA	VGA	3 Mpixel	3 Mpixel
Number of View-Fields	144	144	9	9
Optical Enlargement	100x	100x	60x	60x
Chip Scan Time	1 Min	1 Min	20 Sec	20 Sec

4.7 VERSION OVERVIEW. MODEL RSV8 VERSUS RSV10 AND MODEL RSV80 VERSUS RSV100

The RSV8x and RSV10x series readers are manufactured with the same optics and mechanics structure. The difference is in the electronics and the computer structure. The RSV10x series reader is built with embedded computer, so external computer is not necessary for the routine operation. But of course, for his/her convenience the user can interconnect external device through WiFi service, as the RSV10x reader is equipped with a complete web server. The RSV10x reader is equipped with a front panel touch screen, which is utilized as an input device for the routine operation control.
Typical configurations are described here.

Configuration Example #1.
The RSV10x reader is applied with external monitor, keyboard and mouse. This is redundant structure as all the routine controls are available at the touch screen, too. But this structure may be convenient in particular at using that commands, which are necessary much less often, for example at troubleshooting or maintenance.

Configuration Example #2.
The RSV10x reader is applied together with an external (remote) computer, where the latter is interconnected via VNC (Virtual Network Computing). At this case the external computer's display, keyboard and mouse or touchpad are utilized like they were the reader's own periphery devices. In other words, the computer's periphery devices work as the mirrors of the reader's periphery devices. All the controls and DMU software are available through the remote computer.
The reader own built-in computer cannot access any local services of the remote computer. So the reader can not send data file to the remote computer data storage devices. Therefore at the case of data exportation of measurement results, the pen drive should be interconnected to the reader and not to the remote computer.
Of course, not just desktop or laptop computer can be interconnected via VNC, but if it is wished, tablet computer or even smart phone, too.
Configuration Example #3.

The RSV10x reader is applied as a standalone unit. At this case there is no any external periphery or computer interconnected. The reader works as an entirely autonomic measurement equipment. The control commands, like starting measurement or exporting data file, are invoked using the front panel touch display.

4.8   ROUTINE OPERATION WITH THE RADOSYS RS-RM VERSION TRACK ANALYSIS SW

The routine analysis procedure is described here. The Radosys RM version software is full of software features, but the majority of these options are dedicated mainly for research and for advanced operation. The description of the extra, non-routine options is available in the Advanced Operation chapter.
The flow chart of the RM version software is displayed in Chapter 7.6.1.

The actual appearance of the screenshots from the computer screen may differ from those, which are shown in this document, as various Linux versions and software implementations may be different. Use these images as illustrations.

At the RSV10x series readers in standalone mode the desktop of the embedded computer is not accessible directly. All the controls and operation information are available on the front panel touch screen.

4.8.1 STARTING UP THE RADOSYS TRACK ANALYSIS SYSTEM

Power on the Radosys Computer and the Microscope according to the instruction described in the Installation Guidance.

As soon as the login window is displayed login to the system. Apply the login data as follows:

Login: rm

Password: rm (This is the default value, can be personalized later)

The default desktop image will be displayed on the screen:

4.8.2 ROUTINE ANALYSIS
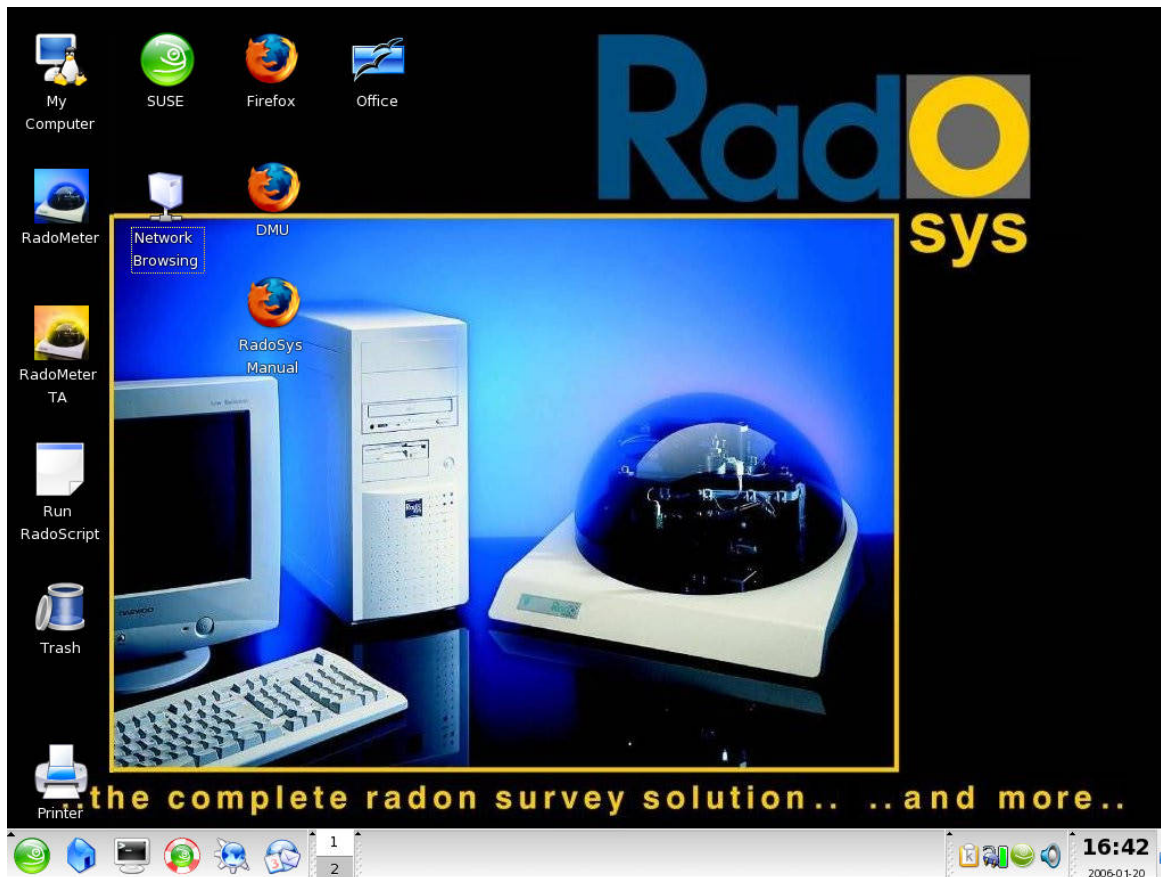
1. Click on Radometer icon on the desktop in order to invoke the analysis software. If the hardware installation is correct, the image of the initialization is displayed on the screen, and the hardware self-test of the microscope starts at the same time. Latter produces an unambiguously unique sequence of motor noise produced by the microscope. The initialization takes about 90 sec.
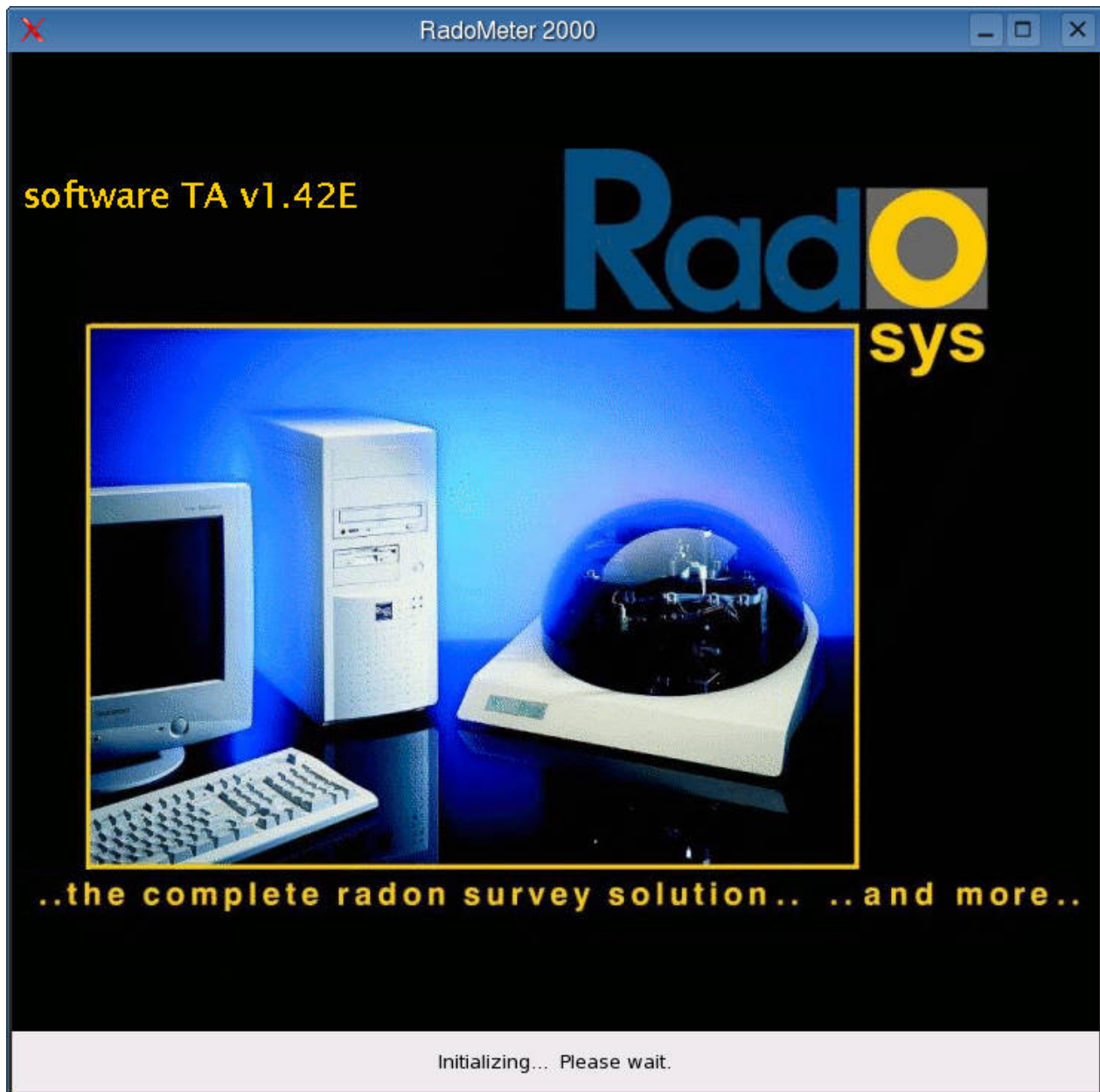
Note:

Two different application software are used for neutron and radon track analysis. At a few installations both of them may be available on the desktop. Please distinguish them, as follows.

Radometer-TA   is to be applied for neutron analysis.

Radometer-RM   is to be applied for radon analysis.

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2. After the successful initialization the Radosys Track Analysis software start-up image is   displayed.

At the upper left corner of the main Radometer window, there are five control buttons, which are provided for speed access of the most important operation functions, as follows.

Speed access buttons:
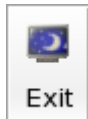
Exit   Quits the Radometer software

Feed   Starts the insertion of a detector holder into the Microscope

Drop   Starts removal of the detector holder being inside the Microscope

Start   Starts automatic processing a detector holder

Stop   Stops the process of track counting

RadoMeter 2000

File   Measure   View   Maintenance   Help

Exit   Feed   Drop   Start   Stop

TA v1.42E
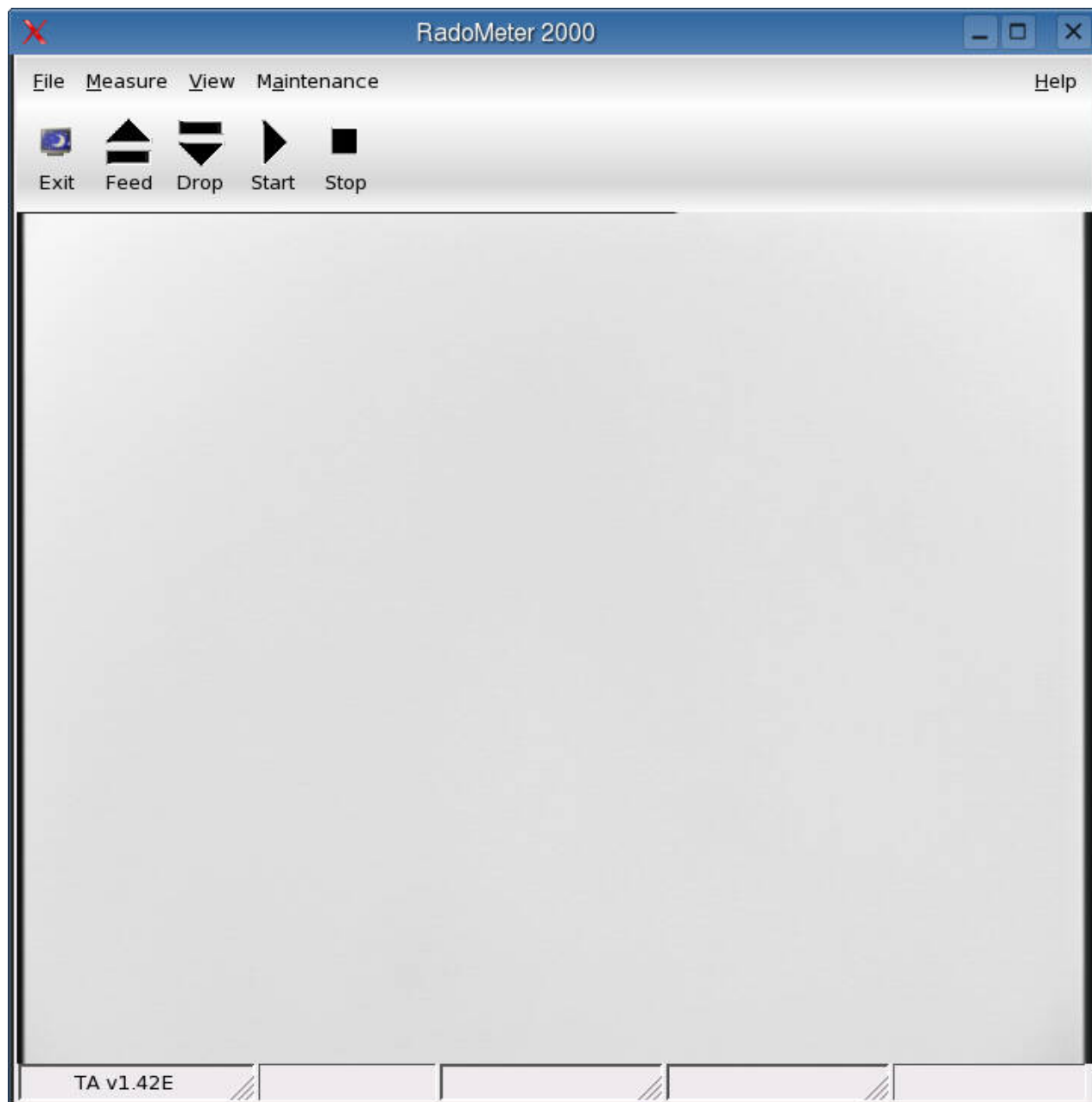
3. Start the Automatic Analysis by clicking on the on the Start button.

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Automatic Measurement

Slide ID: 2006-01-20/001 AutoID Pass: 1

◉ Measure all detectors
◯ Specify IDs and positions

Parameter set: Neutron 1 ⯯ Edit...

Comment for this slide:

OK Batch Cancel Loop
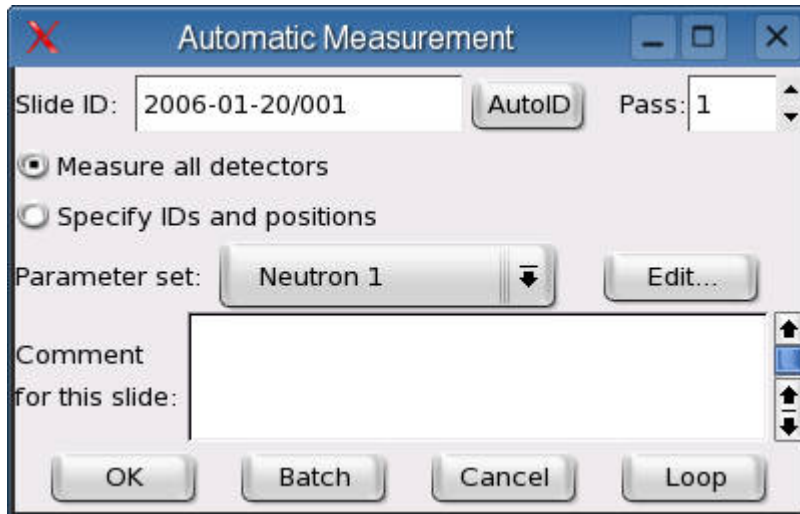
4. In the Automatic Measurement window select the proper EPS, as follows. At the "Parameter Set" pull-down menu select the proper evaluation set among the available sets.
- Select "Neutron 1" for neutron analysis.
- Select "2K Small Tracks" for radon analysis.
Than click on the OK button of the Automatic Measurement window.

5. Now the Microscope unit advances its slide tray ahead in order to make it prepared for the insertion of the detector holder. In other words the slide door is opened now.

RadoMeter message

Please insert next slide!

Cancel

6. Insert the detector holder to the slot, like a credit card to a teller machine. The holder is equipped with structural code; therefore this can be inserted with a definite orientation only.

7. After the insertion of the detector holder the track counting starts automatically. All the 12 detectors of the holder are processed automatically.

8. When the analysis of the whole holder completed, the Microscope drops the holder by means of advancing it ahead on the slide tray. Now remove the detector out of the microscope's slide tray.

9. Now the track counting has been completed.
For visualization of the track data and statistics use the DMU database management utility software, which is described in the section "Listing the Results".

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4.8.3 HELP FEATURES

Help information about the whole software operation, especially about the available control buttons are accessible via two ways.

The feature of drag-on pop-up message boxes
Most of the control buttons is equipped with this feature.
Just drag the mouse pointer to a control button and a pop-up text box in yellow is displayed with a short description about its function.

The feature of Help off-line User Manual
At the RSV6 version of the Radosys system, the User's Manual is an integrated part of the Radometer software. This is accessible in the Help menu of the Radometer software. This feature is available in the menu line of the main Radometer window. Click on the Help menu option to enter the off-line documentation of the Radosys system. An internet-like browser window is displayed, where the Radosys User Manual can be leafed and read locally like an internet web-site.
Note: The most comprehensive version of the Radosys User Manual is distributed in printed or in PDF format. The off-line documentation is updated by means of regular software upgrades. Please ask the local vendor or Radosys Ltd for the latest version of the off-line documentation.

4.9   RSV60 MODEL SPECIFIC SOFTWARE OPERATION

The only difference between the RSV6 and RSV60 microscope models, that the slide management operation is different. The RSV6 model was designed for handling one slide only; that is 12 detectors per each analysis session. This model ensures 20 minutes of continuous operation without any user interaction.

The RSV60 model was designed for handling 24 slides; that is 288 detectors per each analysis session. This model ensures 7 hours of continuous operation without any user interaction.

Note: The typical maximum analysis time per detector is 1.5 minutes at the default EPS settings, which is recommended for routine analysis. The process timing referred above was calculated according to this standard process rate.

The RSV60 Model specific software operation is described in this chapter.

4.9.1   THE MAIN RADOMETER WINDOW AND EXTRA BUTTONS AT RSV60 MODEL

Two model specific, extra buttons [Fill] and [Pause] are available.

    Click on this button to start filling up the slide stack.

After activation of this feature a message window requests to insert the next slide.
Insert the next slide into the front slide slot.
The inserted slide is moved to the slide stack automatically.
Two LED lamps, a green and a red one informs about the status of the slide movement.
When the green lamp is on, this indicates that the equipment is ready for the next slide.
When the red lamp is on, this indicates that the current slide is under movement process and the equipment is busy.
When the red lamp is blinking, this indicates a feed error condition.
Maximum 24 slides can be stored in the slide stack.

II
Pause

Click on this button to pause the track counting process. The button text alters to <Continue>. Click on this button to continue the process.

4.9.2   THE AUTOMATIC MEASUREMENT WINDOW AT MODEL RSV60
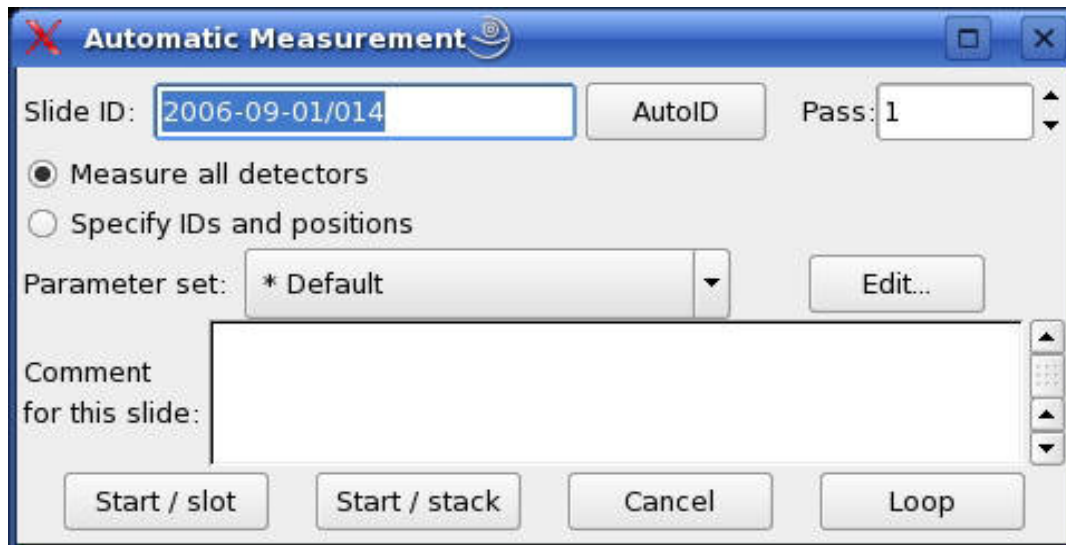
The Automatic Measurement Window at RSV60 Model version.

There are two extra, model specific buttons available at RSV60 version.

<Start/Stack> Clicking on this button, the measurement process of the slides stored in the slide stack is starting. All the slides in the stack are processed subsequently and automatically.

<Start/Slot> Clicking on this button, the measurement is carried out with a slide, which is inserted to the front slide slot, regardless to the status of the slide stack. Therefore a slide insertion will be requested by the control software.

4.9.3 *HOW TO REMOVE SLIDES FROM AUTO-FEEDER UNIT AT CASE OF SLIDE STACK FAILURE*

Use this information only if the auto-feeder stopped working correctly and slides stuck in the feeder.

At case of malfunction in the slide transport mechanism the next slide is not forwarded by the automatism from the slide stack. This is a failure condition, which can be resolved by the operator.

Whenever slide stack operation failure condition is detected by the control software, the software offers a set of control buttons to move the stuck slide remotely. Those controls are Front Motor In, Front Motor Out, Mid Motor In, Mid Motor Out, Stack Plate Down, Stack Plate Up.

First use these control buttons to make the stuck slide moved. Use the description below only if the situation could not be resolved by the software level control buttons.

If the slide stuck condition seems really severe, more intervention is needed manually. This procedure is described below.

1. Insert a size 2.5 hexagonal key in the screw on the step motor of the auto-feeder unit. Alternatively, you may rotate the lead manually with your finger.
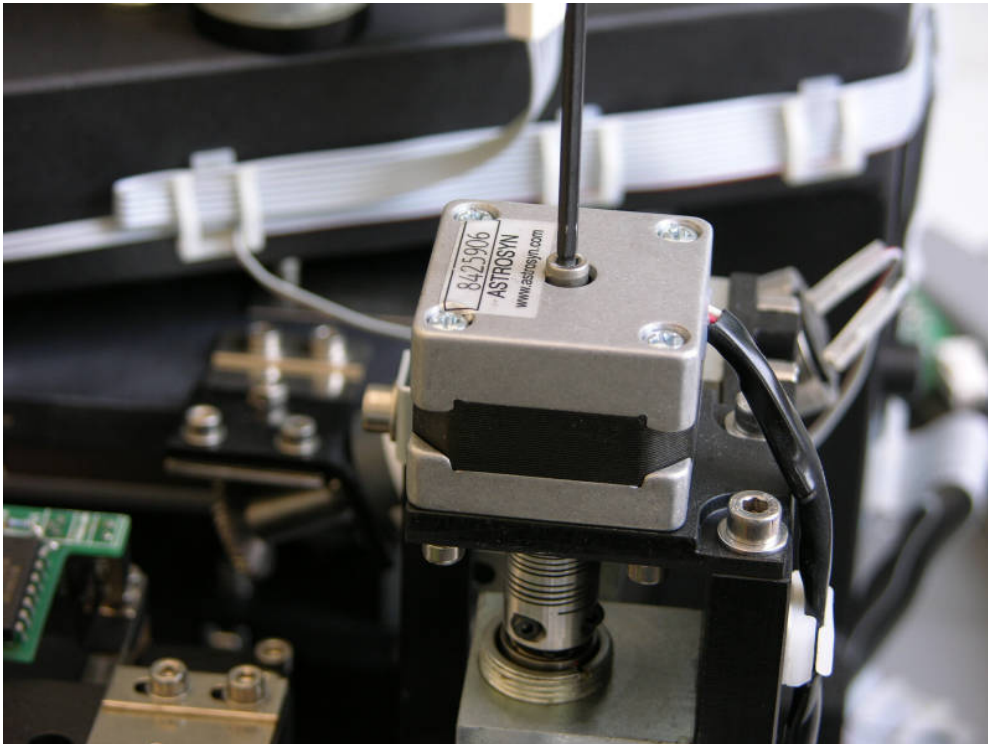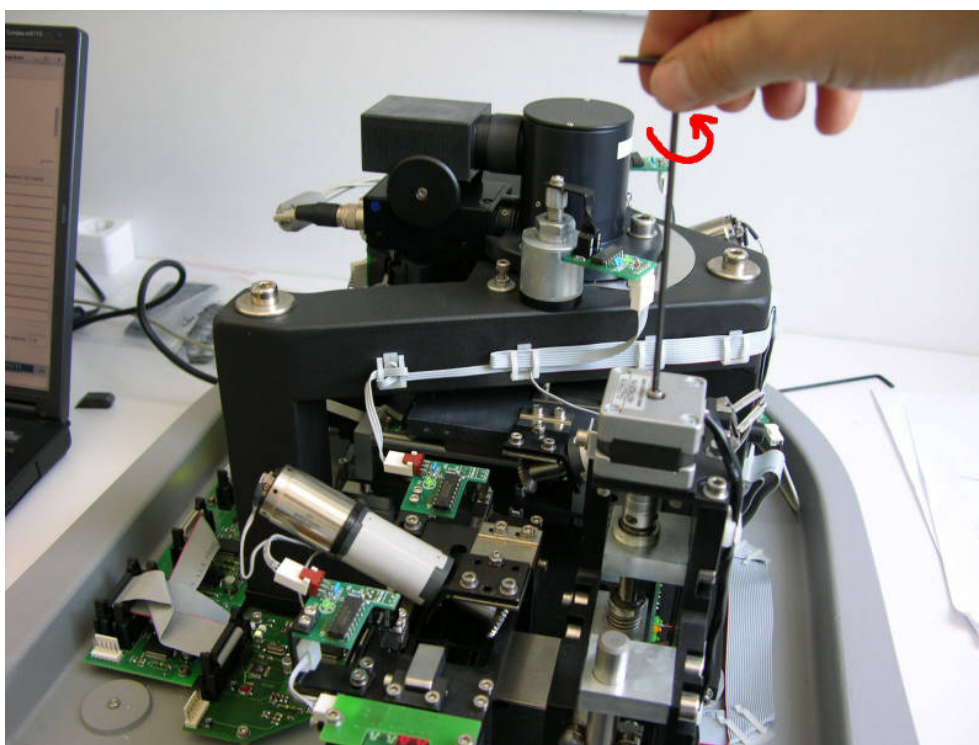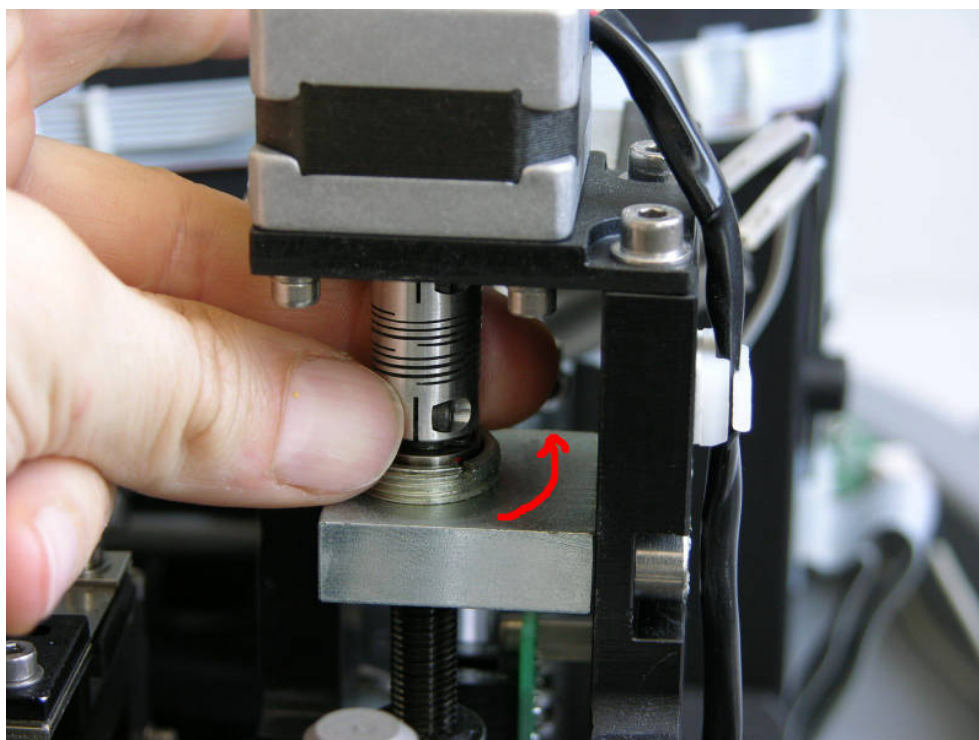
2. Rotate the screw counter-clockwise until the slides are lowered so that the slide holder tray is in the lower region of the autofeeder unit.
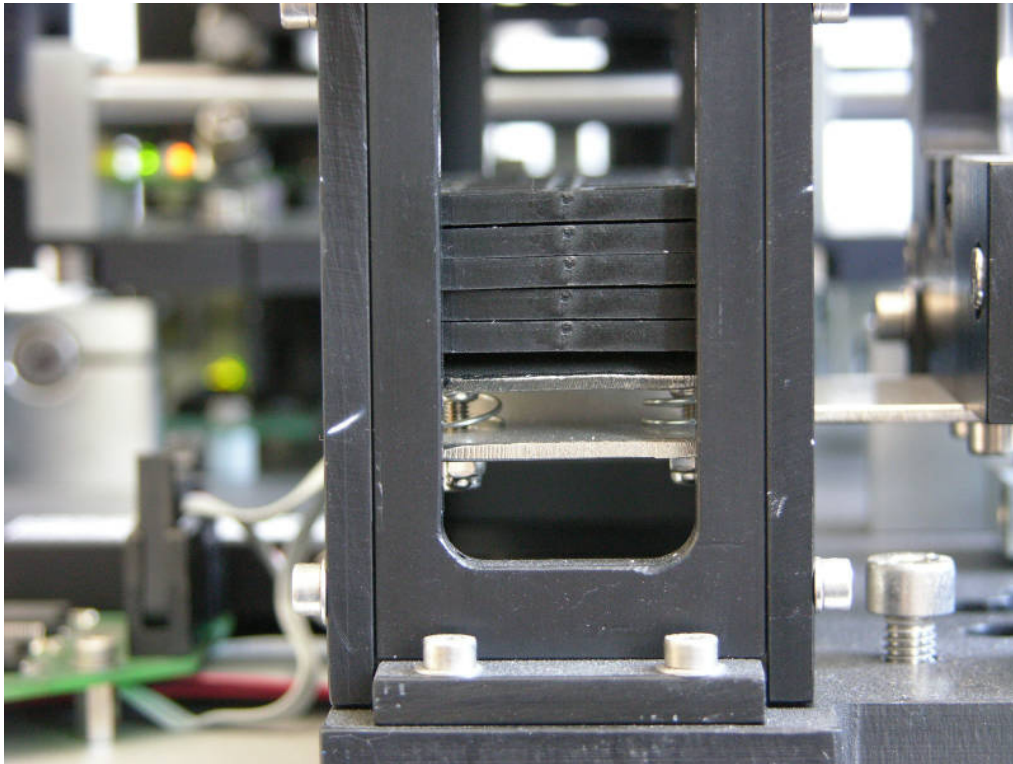
3. Tilt the slides.
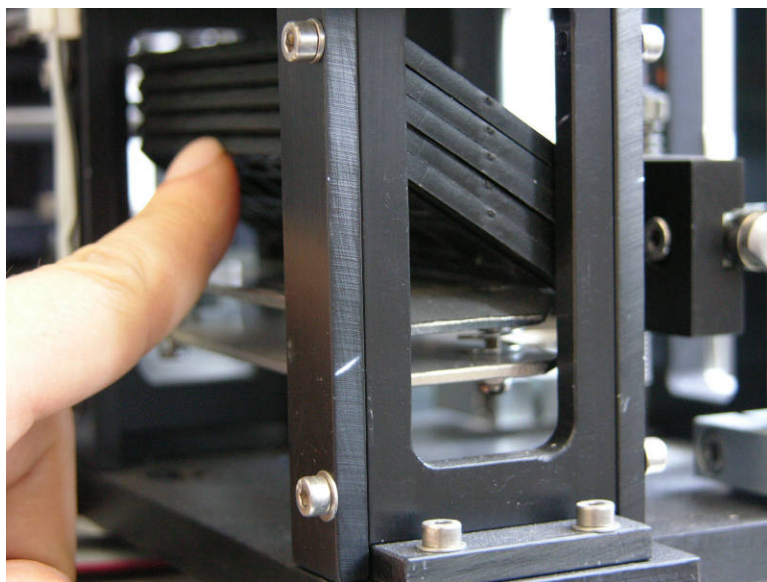
4. Remove the slides by pulling them.
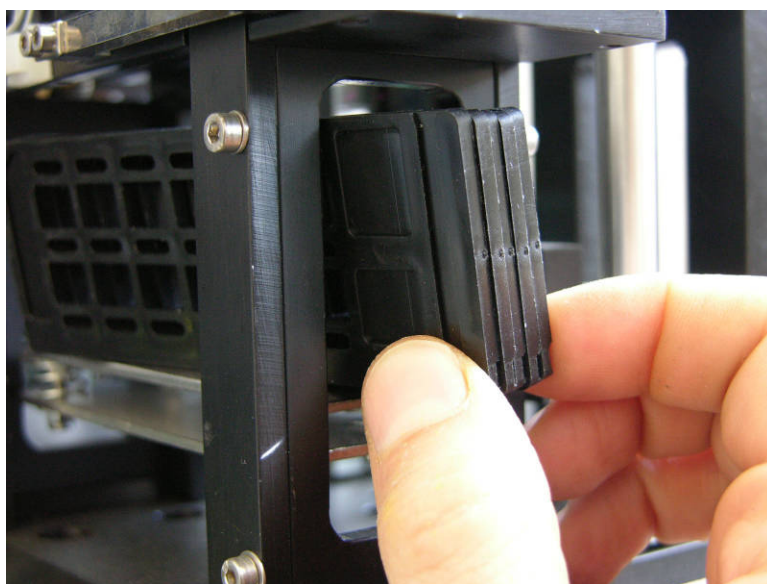
4.10   RSV10x MODELS SPECIFIC OPERATION

The RSV10 and RSV100 models is equipped with embedded computer and front panel touch screen. All the controls and operation information are available on the touch screen. When the unit is used as a standalone measurement equipment, this is the only way to access those.

In this chapter the touch screen related routine operation is described.

The RSV100 specific auto-feeder operation is described in the 4.10.1 subchapter.

When the RSV10x series reader is in idle status, the touch screen is off, but it is sensitive to touching. Simply touch the blind touch screen to make it active. The following is displayed.
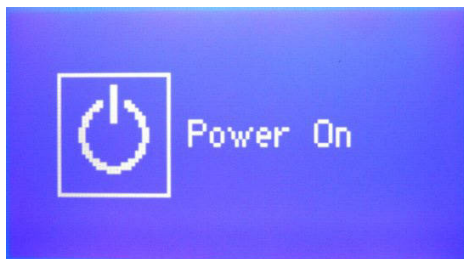
Keep the Power On button touched for 2 seconds to power up the reader.

Then the following starting up cycle is seen for a few minutes.

After powering up the system automatic self-check is done, while the following is displayed.
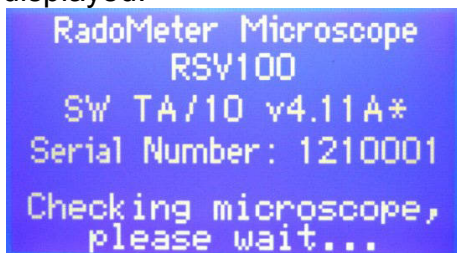
Once the self-check is completed, the Main Menu is seen.
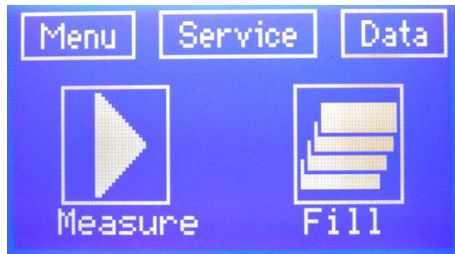
Select Measure then choose Evaluation Parameter Set. The default parameter set is the so called Wide-Size-Range, which alternatively may be listed as WSRx, where x is the EPS version number. If other parameter set is wished to utilize, scroll through the available EPS's (Parameter Sets) using the horizontal arrow keys.

To start the actual measurement select Slot, which means the slide is requested to insert in the slide-slot.
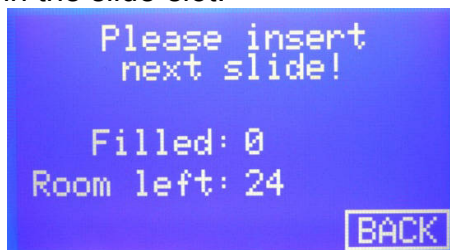
Insert the slide of detectors in the slide slot. Once the measurement is accomplished on all the twelve detectors, the Main Menu is seen again.

To export the measurement results into data file, select Data on the Main Menu screen.

Choose Current day if it is wished to export that data only, which was produced today. Alternatively choose Export All to export all the data have been already stored, including historical series.

System Maintenance

After powering on the instrument, push the "sys" part of the logo. The text in the upper part of the screen will change to "loading system maintenance, please wait...". After a few seconds a menu will appear.

Network setup

Two modes are possible: network client (either wired or WiFi) or WiFi access point.

- In network client mode, the instrument will attempt to register in the local network. If password is needed for the WiFi connection, then a screen and keyboard is needed to set it up. This procedure has to be done only once. On subsequent start-ups, the instrument will register to the WiFi network automatically.
- In WiFi access point mode no local network is needed, the instrument will create a hotspot. After selecting this mode, a channel has to be chosen. If there are other hotspots in the building, try to find an unused channel. After accepting the setup, a hotspot with name radosysNNNN (NNNN is the serial number of the system) will be seen on nearby WiFi-capable devices. The connection is password-protected, the password is 'Radosys123'.

Using an external computer to connect to the instrument

If the instrument is successfully networked, its operation can be observed and the results can be accessed from another networked computer or mobile device. The IP address of the system can be retrieved by touching the "Data" menu on the touchscreen and then selecting "Show IP". Writing the IP address of the system to a browser window will show the RadoMeter control panel.

Observing the operation of the microscope

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- Click the <u>RadoMeter Desktop</u> link. The browser will open a new window and a Java applet will prompt for a password. Type "Radosys" and the desktop of microscope will appear in a new window.
- Any other VNC viewer software (RealVNC, TightVNC, etc.) can also be used to see the screen of the RadoMeter microscope.

Retrieving the results from the microscope

- Click the <u>DMU</u> link. Log in as "dmu" user with password "Radosys". The results of the current day can be seen on the next screen.
- Change the from-to dates and then click select to view earlier results.
- Type in some text in the Search box to look up a specific result.
- Results can be sorted by clicking the arrows in the column heads.
- The currently shown dataset can be exported to CSV file by clicking the CSV button.

4.11 VISUALIZATION OF RESULTS. THE DMU SOFTWARE.

The Radosys track counter software was designed mainly for routine application. This means that the measurement process can be started and completed by easy to follow recipe. In the chapters <Routine operation with…> this recipe is described in the form of step-by-step instructions.

However the software is full of software options. If you use the system the first time, or you do not want to familiarize yourself with other options, just simply use the routine operation recipe. If the recipe followed precisely, the system will provide accurate measurement data. You may need to read the chapters <Advanced operation…> only for research purpose or for troubleshooting.

4.11.1 ROUTINE OPERATION WITH DMU-99 VERSION SOFTWARE

The result of the evaluation is stored in a database managed by the LINUX POSTGRES system. In the Radosys environment this database accessible through the DMU, Database Management Utility. The DMU is HTML-based system, which can be visualized by a standard Internet browser, like the Netscape. Since the Netscape is a normal accessory of the SUSE LINUX, this is applied here being the default application for this purpose.

4.11.1.1   Starting the DMU:

The RadoMeter software automatically launches the DMU, the Database Management Unit. If

you want to run it without switching the microscope on, click the "DMU" icon   on the desktop. You will see the following startup screen:
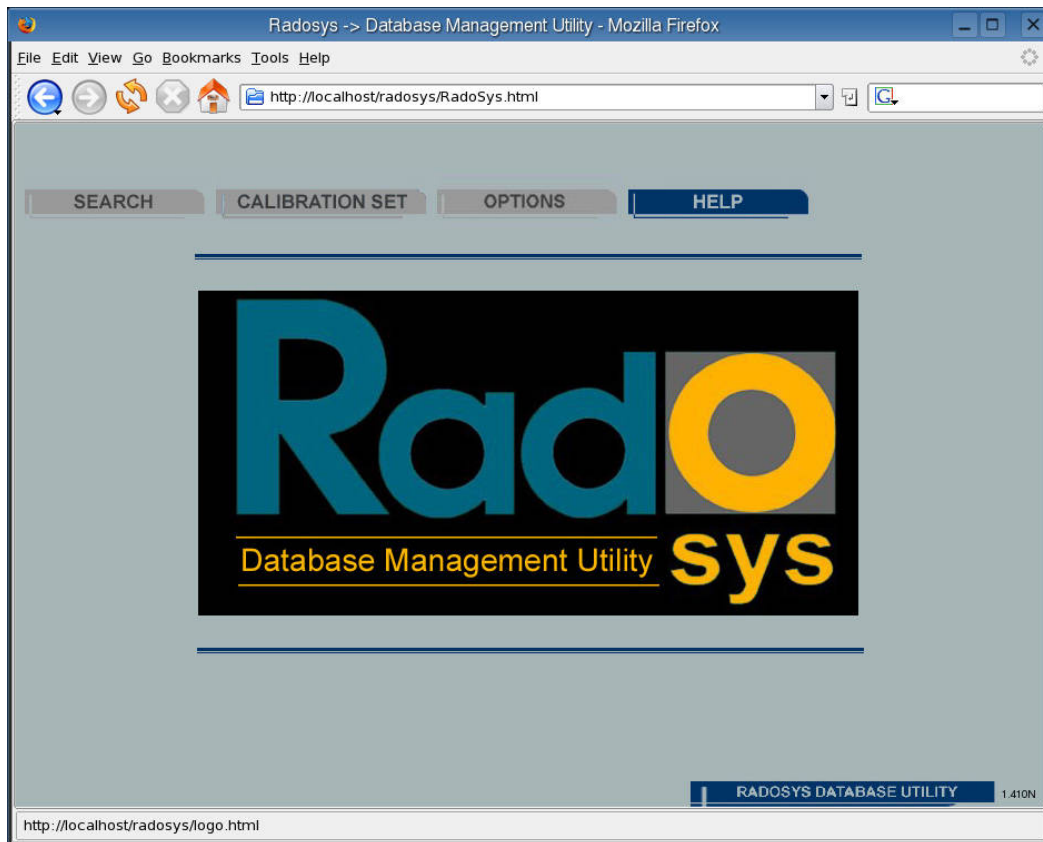
4.11.1.2   Dump the results

To list the results, click the "SEARCH" tab. The Search Window appears:

In the "Select field type" box, select the field you want to base your search on. It can be the Date, the Slide ID or the Detector ID. If you choose "Date", the "Search For" field will be filled with the current date. Note: date format is yyyy-mm-dd (4-digit year, 2-digit month, 2-digit day). You can perform a wildcard search with not filling the whole field. For example, if you write "2006-02-", the resulting table will contain all data from the whole month.

You can change the listing order and the displayed fields by selecting the appropriate controls. It is possible to display additional fields by clicking the "Advcanced Mode" button.

After clicking the "Search" button, the result list is displayed:

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NO	DET_ID	SLIDE_ID	DATE	DENSITY	DOSE	WARNING	COMMENT	DET_COMMENT
1	B62349	2006-01-25/001	2006-01-25 14:19	1.79487	0.538461			
2	B62355	2006-01-25/001	2006-01-25 14:17	1.36752	0.410256			
3	B62355	2006-01-25/002	2006-01-25 14:31	1.36752	0.410256	I		
4	B62355	2006-01-25/003	2006-01-25 14:37	0	0	I		
5	B62355	2006-01-25/004	2006-01-25 14:47	0	0	I		
6	B62355	2006-01-25/005	2006-01-25 14:57	0	0	I		

Update   Export To File   Export Field Data

Export Track Data

RADOSYS DATABASE UTILITY   1.410N

If the results do not fit on one screen, you can proceed to the next one by pressing the "Next >>" button.

You can export the results table to a text file by pressing the "Export To File" button. The exported file can be imported into a spreadsheet software. Clicking the number in the density window opens a new window with detailed results.

4.11.1.3 Refine the results

In order to convert the counted track density to physical value of R.A.C.:
Fill on the Start_Date and End_Date fields to indicate the exposure time
Scroll the window to access the paginate operation buttons.
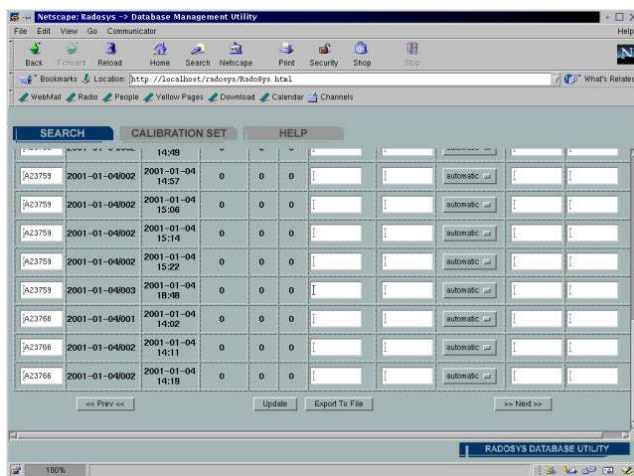
Click on the Update button
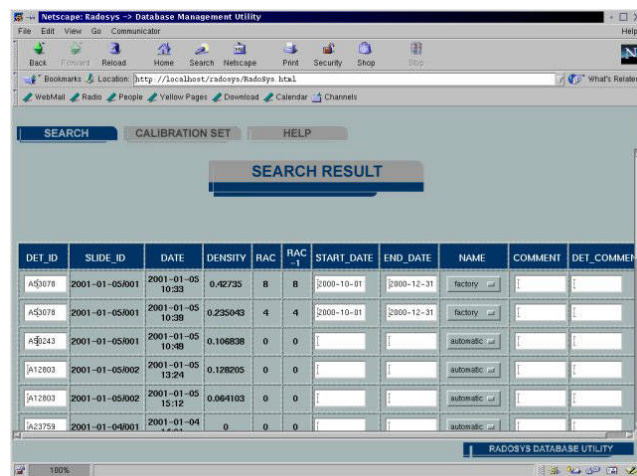
The Radon Activity Concentration value is calculated and displayed in the RAC column,
expressed in Bq/m^3.

4.11.2 GENERAL INFORMATION ABOUT THE DMU-V6X SERIES SOFTWARE

This software version is a straightforward update of the former DMU-99 version. The main difference at the DMU-V6X series software that the user interface is different. While the DMU-99 version has utilized an internet-like browser, the new version operates with its own graphics window, which had been developed for this application exclusively. In respect of the available data and result reporting, the DMU-V6X is equivalent to the former DMU-99. This works with the same data/result service concept. Nevertheless of course, the DMU-V6X was designed to be more users friendly and is more convenient to use.

Two sub-versions of the DMU-V6X software are available today.
- The version DMU-V6R is dedicated to radon test application.
- The version DMU-V6N is dedicated to neutron dosimeter application.
There is just minor difference between these two sub-versions. A few data fields are different, according to the different nature of these two applications. Moreover, at the V6N version the track classes concept has been implemented, which option is missing in the V6R version at all. It is also worth to mention that the calibration data service feature works differently at the V6R version, also because of the different nature of the radon test application.

4.11.3 ROUTINE OPERATION WITH DMU-V6R VERSION SOFTWARE

Only the most often used, routine steps are described in this chapter.

For information about the advanced features read the Chapter 5.5, "Radosys DMU Software Advanced Operation.

4.11.3.1   Information for users, who are familiar with the previous version DMU-99

The most important difference between the DMU-99 and the DMU-V6R is listed here.

- The software works with its own graphics interface, while the DMU-99 worked in internet-like browser window. This also means that accessibility through network is not available, while the DMU-99 supported this feature.

- Now the result chart is displayed in the main window. Updating the result chart is not necessary. Any edited data or change at the configuration will update the result chart instantly.

- At the data export function, the data is exported in csv formatted text file, while the export file format was tabulated text file. Therefore who has already utilized data importation into other application software, for instance to Excel, those one should revise their data importation practice.

- Now the result chart is configurable much easier. Individual configurations can be designed and the stored configurations are selectable from a list.

- Database archiving feature is available now.

- The EPS of the measurement is a list option in the result chart. The details of the applied EPS is also available to list. This feature enhances the integration between the Radometer track reader software and the DMU software.

- The whole chart of the CF [Calibration Factor], which is provided by Radosys Ltd, can be imported into the DMU software. When internet connection is available from the control computer, the CF chart can be updated just by a single button operation.

- Feature of Detectors' Group Edit has been introduced. Editing detector properties, like Start/End Date or Comment, is no longer limited to a single detector individually. Now this can be done for a whole detector ID range at the same time.

- The Detector Thumbnail feature has been introduced. Switching on this feature, the map of recognized tracks is displayed in a separate window.

4.11.3.2   Starting the DMU-V6R software

Locate it and click on the program icon DMU-V6R on the Desktop to start the software.

Note: Whenever the main program, the Radometer software is started, the DMU software, in a separate window, is also started. If more versions of the DMU software is available at your computer, just one version will be invoked automatically. The DMU version, which was started automatically, depends on the default system configuration. When other version of the DMU software is also available at your computer, this should be started individually, by clicking on its icon at the Desktop. More versions of the DMU are allowed to be active at the same time.

Application example: Let's assume that the DMU-99 software has been started automatically together with the main Radometer software, but you rather want to use the DMU-V6R version. Just locate it and click on the program icon DMU-V6R on the Desktop to start the software. Simultaneous availability of different DMU versions does not make any trouble. Just use one of them by your preference.

As a general rule in Linux and in Windows you may alter the active program window by the key combination ALT+TAB.

After starting the DMU-V6R software the following, typical window content is displayed.
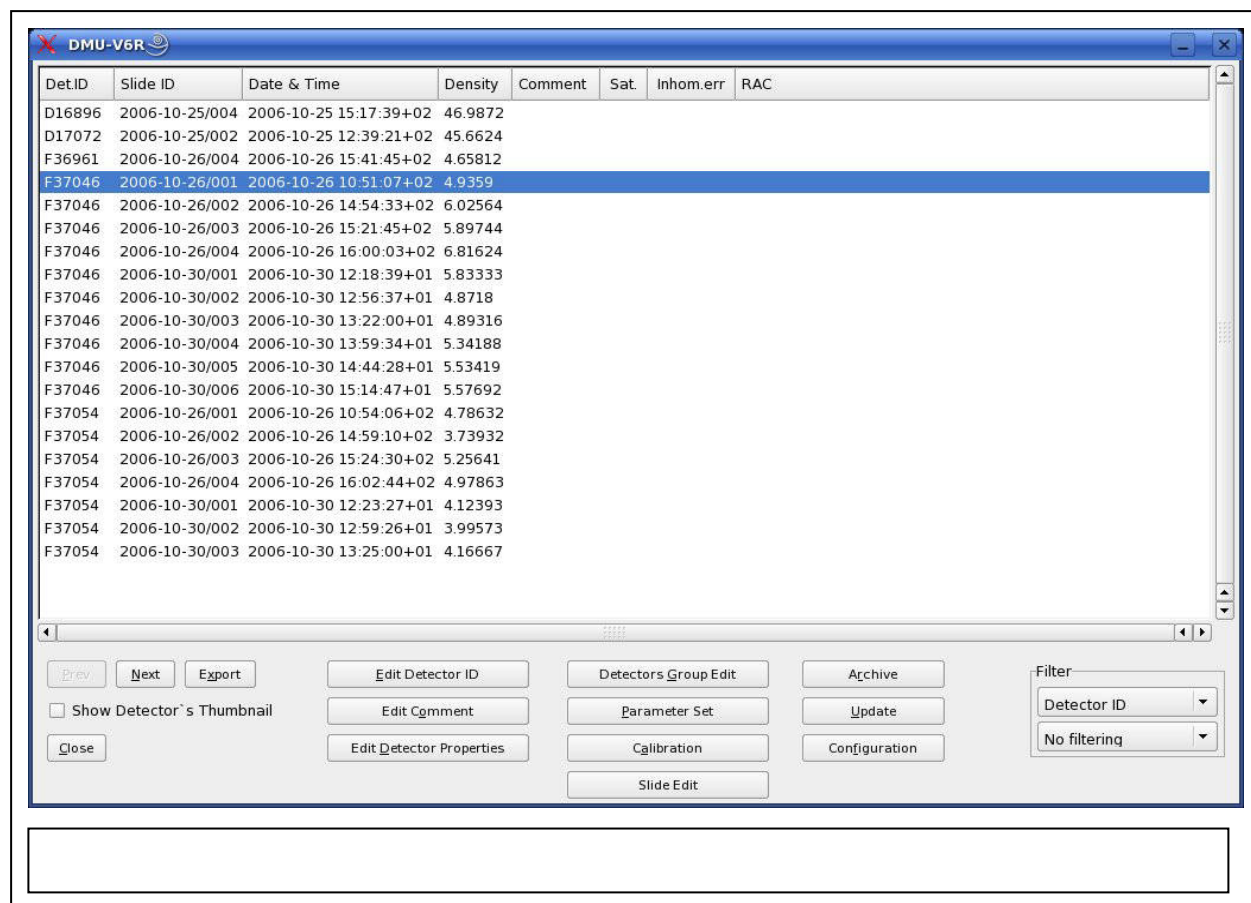
General description of the main sections of the DMU window:

Result Chart:
This is a table, where the measurement data is tabulated. Each row consist of a series of data about one detector, which detector is identified by <Det ID>.
Chart Header:
Each element of the header serves as column header to indicate which type of data is listed in its column.
The displayed columns can be configured by the user.
The default chart configuration is the <Routine Test 1>. A newly installed DMU software displays the chart according to this default chart configuration:
<Det ID>, <RAC>, <Density>, <Start Date>, <End Date>, <Slide ID>, <Date&Time>
Window Controls.
- The <Next> and <Prev> buttons are to turn a page forth or back, when the size of the chart is bigger then the window itself.
- For information about the other buttons, read the Chapter ….
Edit & Settings Controls
These group of buttons consists of various tools, including editing specific detector's data, chart configuration and also access to the calibration service.
- The button <Edit detector properties> opens a window, where the <Start Date> and <End Date> data of exposure time can be set.
- The button <Configuration> opens a window, where the result chart can be configured, or where the active chart configuration can be selected.
- For information about the other buttons, read the Chapter ….
List Filter Controls
The filters determine which detectors are listed. In other words, this is a search tool. The detector database can be searched according to various keys, and only those detectors are listed in the result chart, which detectors meet the criteria of the filter settings.
-The default settings of the Filters is:
--- Listing by <Date>
--- <Latest Date> option is applied
At this case of default Filter settings, the most recently measured detectors are listed.
- For information about the Filters more in details, read the Chapter ….
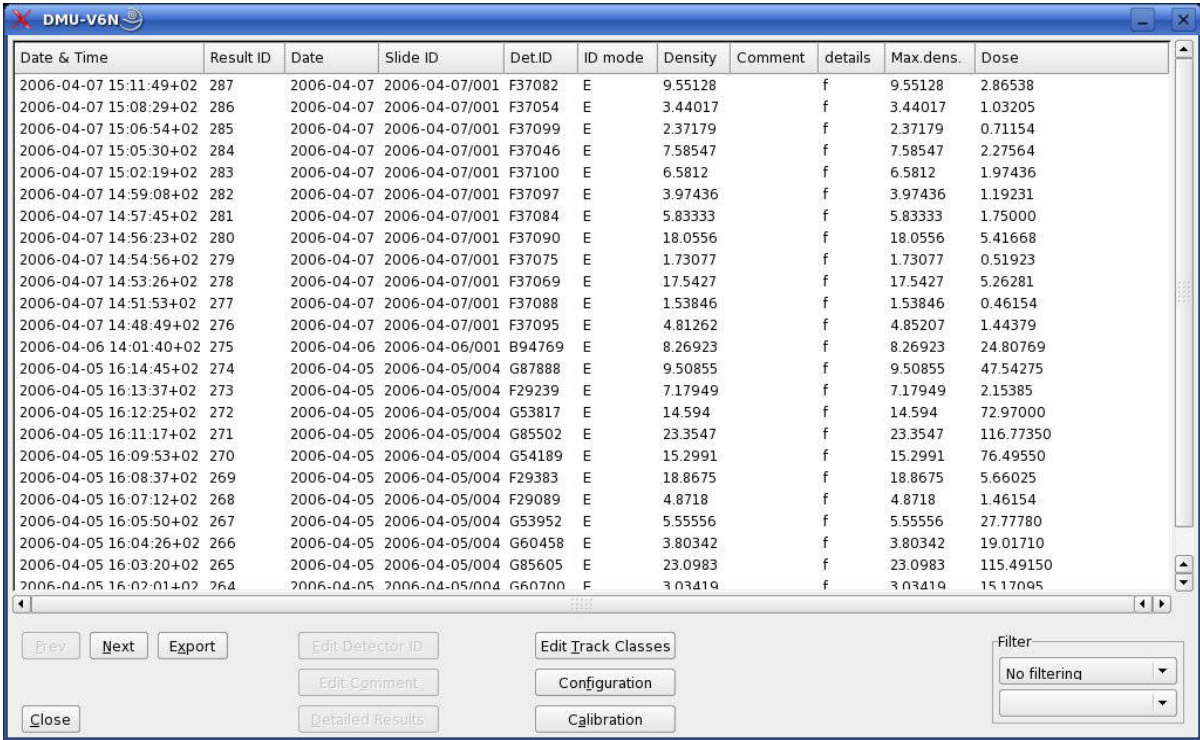
4.11.3.3   Listing the results

1. At this description about the routine operation, it is assumed that the default Chart Configuration is used. If it has happened that the Chart Configuration had been altered, click on the button Configuration and select the Chart Configuration <Dates>.
2. Check the Filters settings and ensure that <Date> and <Latest Date> default options are displayed. If it has happened that the Filters settings had been altered, set them to the default.
3. Update the desired detector's row in the chart by editing the <Start Date> and <End Date> data. The RAC, Radon Activity Concentration, in Bq/m^3, value is displayed only if the time of exposure, defined by Start Date and End Date, was introduced to the database. To do so, click on the button <Edit detector

properties> and edit the data fields <Start Date> and <End Date>. For convenience, use the <D> button to display a calendar and to select the dates interactively. After editing the date fields, click on button <Save> to store these data to the database.

4. The RAC value is displayed in the Result Chart instantly.

4.11.4 ROUTINE OPERATION WITH DMU-V6N VERSION SOFTWARE

Date & Time	Result ID	Date	Slide ID	Det.ID	ID mode	Density	Comment	details	Max.dens.	Dose
2006-04-07 15:11:49+02	287	2006-04-07	2006-04-07/001	F37082	E	9.55128		f	9.55128	2.86538
2006-04-07 15:08:29+02	286	2006-04-07	2006-04-07/001	F37054	E	3.44017		f	3.44017	1.03205
2006-04-07 15:06:54+02	285	2006-04-07	2006-04-07/001	F37099	E	2.37179		f	2.37179	0.71154
2006-04-07 15:05:30+02	284	2006-04-07	2006-04-07/001	F37046	E	7.58547		f	7.58547	2.27564
2006-04-07 15:02:19+02	283	2006-04-07	2006-04-07/001	F37100	E	6.5812		f	6.5812	1.97436
2006-04-07 14:59:08+02	282	2006-04-07	2006-04-07/001	F37097	E	3.97436		f	3.97436	1.19231
2006-04-07 14:57:45+02	281	2006-04-07	2006-04-07/001	F37084	E	5.83333		f	5.83333	1.75000
2006-04-07 14:56:23+02	280	2006-04-07	2006-04-07/001	F37090	E	18.0556		f	18.0556	5.41668
2006-04-07 14:54:56+02	279	2006-04-07	2006-04-07/001	F37075	E	1.73077		f	1.73077	0.51923
2006-04-07 14:53:26+02	278	2006-04-07	2006-04-07/001	F37069	E	17.5427		f	17.5427	5.26281
2006-04-07 14:51:53+02	277	2006-04-07	2006-04-07/001	F37088	E	1.53846		f	1.53846	0.46154
2006-04-07 14:48:49+02	276	2006-04-07	2006-04-07/001	F37095	E	4.81262		f	4.85207	1.44379
2006-04-06 14:01:40+02	275	2006-04-06	2006-04-06/001	B94769	E	8.26923		f	8.26923	24.80769
2006-04-05 16:14:45+02	274	2006-04-05	2006-04-05/004	G87888	E	9.50855		f	9.50855	47.54275
2006-04-05 16:13:37+02	273	2006-04-05	2006-04-05/004	F29239	E	7.17949		f	7.17949	2.15385
2006-04-05 16:12:25+02	272	2006-04-05	2006-04-05/004	G53817	E	14.594		f	14.594	72.97000
2006-04-05 16:11:17+02	271	2006-04-05	2006-04-05/004	G85502	E	23.3547		f	23.3547	116.77350
2006-04-05 16:09:53+02	270	2006-04-05	2006-04-05/004	G54189	E	15.2991		f	15.2991	76.49550
2006-04-05 16:08:37+02	269	2006-04-05	2006-04-05/004	F29383	E	18.8675		f	18.8675	5.66025
2006-04-05 16:07:12+02	268	2006-04-05	2006-04-05/004	F29089	E	4.8718		f	4.8718	1.46154
2006-04-05 16:05:50+02	267	2006-04-05	2006-04-05/004	G53952	E	5.55556		f	5.55556	27.77780
2006-04-05 16:04:26+02	266	2006-04-05	2006-04-05/004	G60458	E	3.80342		f	3.80342	19.01710
2006-04-05 16:03:20+02	265	2006-04-05	2006-04-05/004	G85605	E	23.0983		f	23.0983	115.49150
2006-04-05 16:02:01+02	264	2006-04-05	2006-04-05/004	G60700	E	3.03419		f	3.03419	15.17095

Prev | Next | Export | Edit Detector ID | Edit Track Classes | Filter — No filtering
Edit Comment | Configuration
Close | Detailed Results | Calibration

The main window of the V6N version of the DMU software.

4.12 CALIBRATION DATA TABLE UPDATE (CF-CHART)

4.12 CALIBRATION DATA TABLE update (CF-CHART)

4.13 N-DOSYS, NEUTRON DOSIMETRY APPLICATION SPECIFIC PROCEDURE

4.13.1 GENERAL INFORMATION

The whole process is very similar to the radon application. The application specific difference is described in this chapter.

Application specific software version has been developed and made available for neutron dosimetry.
- The track counting software is of the RS-TA-series version. See Chapter 4.5.2.
- The corresponding DMU software version is the DMU-V6N. See Chapter 4.7.4.

The track development requires an extra step, the Pre-Treatment. See Chapter 4.8.2.

Therefore the main sequence of operation at the neutron dosimeter application:
- Exposure of the dosimeter
- Insertion of the detector chips to slides
- Pre-treatment procedure, latent track enhancement
- Etching procedure, track development
- Track counting
- Listing the results

4.13.2 THE PRE-TREATMENT PROCEDURE

4.13.2.1   Preface

A Radosys's propriety technology is used for fast neutron detection.
The essence of this technology is that the latent tracks are made more visible and/or enlarged by pre-treatment in carbon-dioxide. The pre-treatment is a requirement before the main etching step by sodium-hydroxide.

4.13.2.2   The sequence of the Pre-treatment in Carbon-Dioxide

1. Place the exposed detector chips into the holders, as it is described in the Section "Insertion of the detector chips to slides".

2. Install the Pressure Vessel, as it is described in the document "Installation Guidance". Close the Inlet Valve and the Outlet Valve of the Pressure Vessel before connecting to the gas cylinder. Connect the Pressure Vessel to the outlet of the pressure regulator of the CO2 gas cylinder. Keep the outlet valve of the pressure regulator closed.

3. The components and parts of the Pressure Vessel, also a typical pressure regulator for gas cylinder are shown on the pictures below.
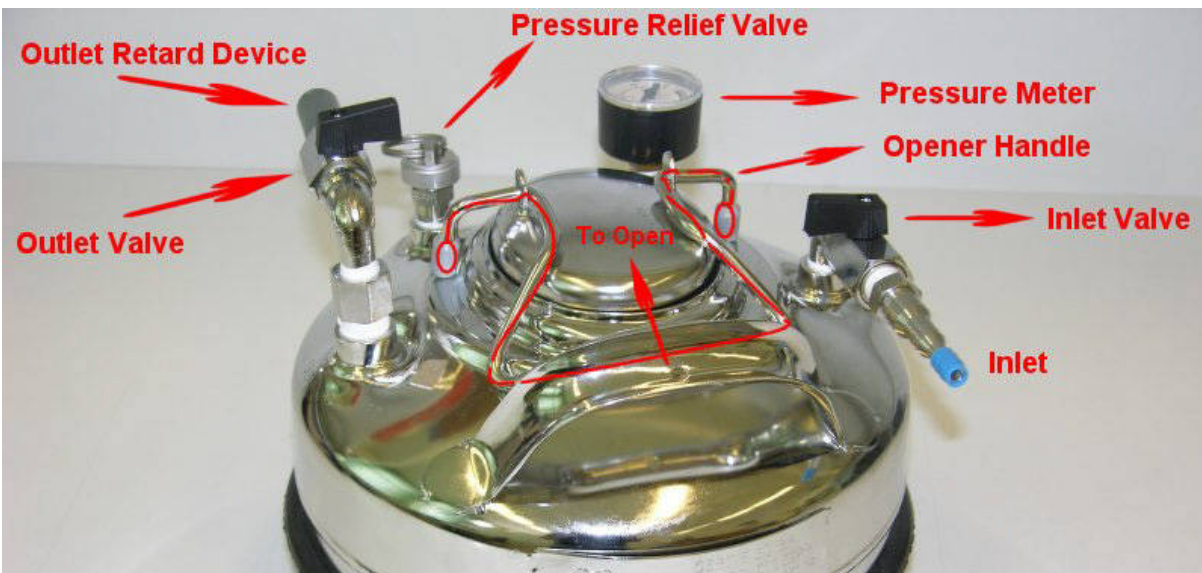
The components and parts of the Pressure Vessel
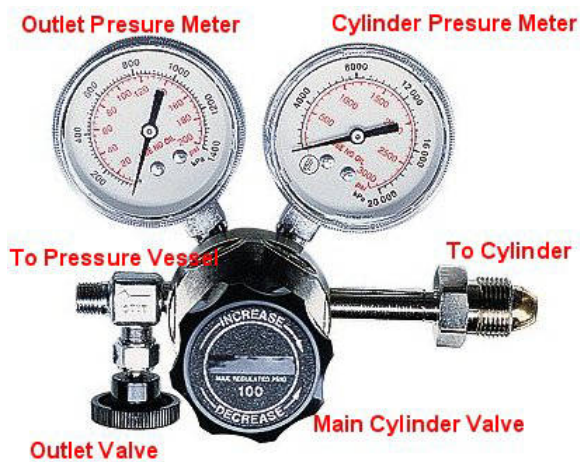
Typical Pressure Regulator for Gas Cylinder

4. Remove the lid of the Pressure Vessel and place the holders of detector chips into the Pressure Vessel. There is no any requirement about the way of placement, just drop them inside.

5. Close the Pressure Vessel by placing the lid to its normal position.

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6. Open the Inlet Valve of the Pressure Vessel.

7. Open the outlet valve of the pressure regulator carefully and adjust the pressure to 6.9 bars. The pressure can be checked by the Pressure Meter of the Pressure Vessel.

8. Once the pressure in the Pressure Vessel reached 6.9 bars, close the Inlet Valve of the Pressure Vessel. Now also the valve of the pressure regulator can be closed.

9. After that preparation, the period of pre-treatment of the neutron exposed detector chips has been started. The time of pre-treatment is 7 days. The exposed detectors should be kept under 6.9 bars CO_2 atmosphere through 7days.

10. After the period of pre-treatment, evacuate the Pressure Vessel by opening the Outlet Valve of the Pressure Vessel. The CO_2 gas content of the Pressure Vessel is released through the Outlet Retard Device, which ensures the safety of the gas evacuation.

11. Open the lid of the Pressure Vessel and remove the pre-treated holders of detector chips.

12. Start the chemical etching of the detectors as soon as possible. Preferably, do not store the pre-treated detector chips before the main etching step of sodium-hydroxide, but start the etching immediately.

4.13.2.3   General Information for the Installation of the Pre-Treatment Pressure Vessel

- The operation of the Pre-treatment unit needs using a gas container filled with Carbon Dioxide, which container should be equipped with a pressure regulator device.

- Concerning to the type and purity of the Carbon Dioxide, there is no any particular requirement, therefore any industrial type can be used. The proper size of the gas cylinder may depend on the frequency of usage. In the practice, the size of 7..10kg, with purity of 99.995% used to be a good choice. For example, the European system users utilize 7.5kg steel cylinder supplied by Linde AG (www.linde.com) with a product designation of Carbon Dioxide type 4.5. This product is supplied by Linde AG together with Certificate of Analysis. Linde products are available worldwide in 50 countries. If this product by Linde AG was not available in your country, please contact a local, major supplier of industrial gases and inquiry about equivalent product.

- The CO_2 gas tank and the pressure regulator device are not delivered together with the measurement system. These devices vary from country to country, according to the local standards. Therefore these devices should be purchased from a local supplier.

4.13.2.4   Technical Warnings

Warning.   Never connect a gas container to the presser vessel directly. Always use a pressure regulator device between the gas container and the pressure vessel. Failing this rule may cause serious injure. This type of pressure vessel, which supplied with the system, was designed and tested for max 6.9 bars pressure operation!

Warning.   Assembling a high pressure gas system by a non-skilled person is strictly prohibited! Only a professional, expertise technician is able to fix a high pressure set-up with safety, who is also familiar with the local standards! The supplier of the system, Radosys Ltd does not admit any responsibility if this strict rule is failed or neglected in any respect.

5 Advanced operation

Beyond the routine, the LINUX environment as well as the extended features of the Radosys software offers a tremendous way of flexible features to create your own everyday practice.

5.1 DESKTOP ISSUES

The most important LINUX options are accessible through the Panel window. This window is displayed when the mouse pointer is dragged to the bottom of the screen.

Each of the active processes can be visualized and get its window to the top at the Taskbar. This window is displayed when the mouse pointer is dragged to the top of the screen.

The file system can be explored easily by means of the graphics Home Terminal. Click on the Home Icon at the Panel window to access it.
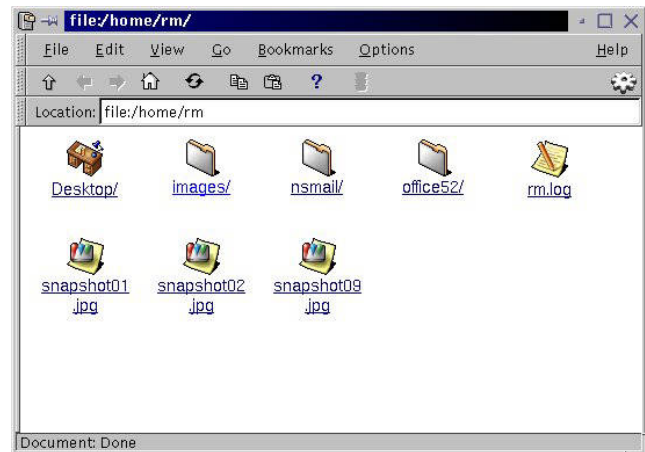
5.2   ROOT USER OPERATION

Any time when a system administration work is needed, the only way is to login as a Root user. However this opportunity should be applied for system administration purpose only. Avoid entering this mode for any other purpose.

The Root user operation is accessible through login with the following terms.

Login: root
Password: RMet2000

Please notice that any textual information in Linux is case sensitive, also the login name and password. Therefore type them exactly as they are written above.

A new login session can be started by the key combination of Alt-Ctrl-F1 to Alt-Ctrl-F6 or by restarting the X-Windows by the Alt-Ctrl-Backspace key combination.

5.3   SYSTEM SETTINGS ISSUES

Any time when a new system sw or hw option should be introduced, this requires the Root user operation mode. This might happened e.g. if a printer or modem device is added to the system.
The easiest way to do this by the YAST system utility.
Drag to the Panel window and click on the YAST icon to invoke this utility.

5.4   RADOSYS RSV6-RM SOFTWARE ADVANCED OPERATION

5.4.1   INTRODUCTION

The flow chart of the RM version software is displayed in Chapter 7.6.1.

5.4.2   DESCRIPTION OF MAIN CONTROL BUTTONS AND FEATURE CONTROLS

5.4.2.1   Automatic Measurement

Soft key combination: Ctrl+A

Description: Automatic Analysis of Detectors. The 12 detectors in the inserted holder card are scanned and analyzed automatically, by means of a sophisticated algorithm analyzing the microscopic images and recognizing the alpha tracks. The output of the analysis is the number of the counted tracks. Each result is stored in the DMU, integrated database of the Radosys system, for subsequent calculation and visualization.

Usage: Select this menu item to invoke this option, or alternatively, click on the right arrow button at the toolbar of the main radosys window. Set the desired analysis parameters in the displayed dialogue window:

5.4.2.1.1   Slide ID

Each analyzed holder card needs an individual identification code. The software generates the default code automatically, however this recommended code can be modified promptly at the start time of the analysis. The default code is generated by means of the current date plus a serial number, which is the next subsequent one with the same date. The format of the default code is yyyy-mm-dd/sss, where "yyyy" denotes the current year, "mm" the month, "dd" the day and "sss" the serial number at the same date. Whatever were decided, either the default code for the holder card or a customized form were selected, it is recommended to place a label with this information onto the holder card.
Notes: If the default card holder ID were modified, but the intention will be changed, one may return to the automatic ID form by clicking on the "AutoID" button.

5.4.2.1.2   Passes

By default each detector chip is analyzed only once. However, the software can be instructed to carry out repeated analyses on each detector chip. The scanned area is set according to the Evaluation Parameter Settings. Any repeated analysis may be useful whenever an increased accuracy is preferred to speed. Repeated analysis may provide a better accuracy, simply because of the general behavior of statistics. (The standard deviation of the mean of *n* measurements is equal to the standard deviation of the measured quantity divided by the square root of *n*.)
You can instruct the software to perform repeated analyses by simply writing the number of desired repetitions (cycles) into the text box in the upper right corner of the window that appears after you click "Start" in the main window. According to the setting on the figure, each reading will be performed three times (the detector ID is read only once).
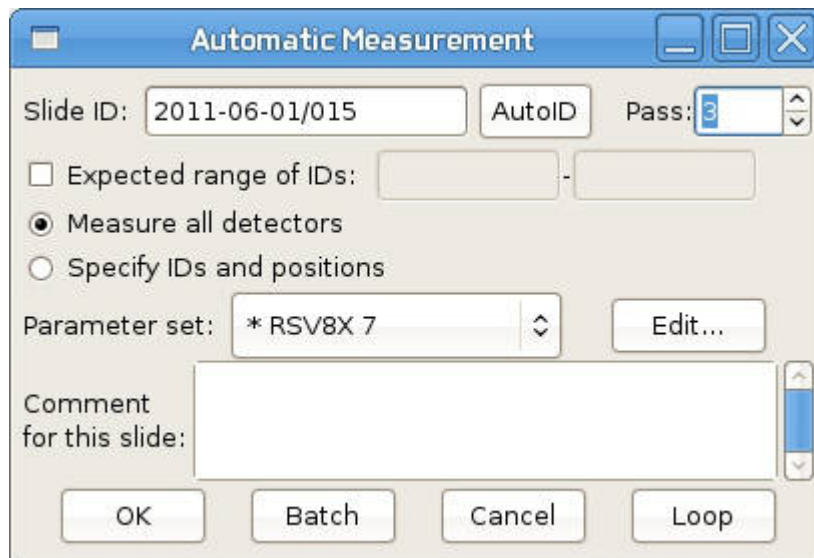
Setting the number of repetitions (cycles) of the readings

The track densities are determined from each reading and the mean, the standard deviation and the maximum of the read track densities are calculated. In the DMU software the mean values are displayed in the "Track density" column, the standard deviations in the "Standard deviation" column, the maximum values in the "Maximum track density" column and the number of cycles in the "Count of measurements" column. For a detailed description on how to display these parameters with the DMU software see section 5.5.3.

5.4.2.1.3 Measure all / Specify IDs and positions

It can be defined what detector chips of the current holder card should be analyzed. The default setting is to carry out the analysis on each of them, however individual dedication for analysis is also available. Actually, a set of detectors for analysis can be constructed, additionally individual Evaluation Parameter Set can be assigned to each detector. Even the default value of ID for each detector chip, that is the value read automatically, can be overridden by entering a new value manually. This option may be useful when the automatic detector ID reading fails. Please find more information about settings option at the subtitle of "Edit Loadlist".

5.4.2.1.4 Parameter set

The Evaluation Parameter Set (EPS) can be selected here. These parameters determine the details of the track image analysis and may influence on the results decisively. Click on the button and select the desired parameter set from the displayed list. If the list is too long to display all the items, select the "More…" item at the end of the list, and the next page of the list will be displayed.
There are a few EPS, which are provided together with new Radosys equipment.

These can be sorted into two groups, according to the type of the detector holder cards, so called Normal or 2K/2L. (This sequence of the different holder cards is in correlation

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with the release date of the holder card types, which releases related to their evolution during the production history of the Radosys. After November, 2001, the 2L type is manufactured and distributed only, however the software have to care of the earlier types as well.) According to this classification the name of any initially provided EPS starts with or without a denotation of 2K. If a 2K or 2L type of holder is applied select an EPS with this denotation. If an older ("Normal") card is applied, select an EPS without this denotation. This rule of denotation for the applied names of an EPS, concerning to the applied type of holder card, is not a requirement. This is intended to be just a guide for easy recognition of an EPS.

There are a few EPS, which are provided together with new Radosys equipment, according to both types of detector holder cards.
Each of these initially provided EPS are optimized for different average track sizes. For the best interpretation of this options, please review the relevant Chapter of the Manual about the Detector Etching process. However for Routine Operation, please follow the next fundamental directive. If the etching process is done according to the standard condition, as it is described in the Chapter "Etching", the most optimal selection is an EPS with a Small Track setting option.

Therefore for radon application the default Parameter Set [EPS] is the "2K Small Tracks". Use other EPS only for research or troubleshooting purpose.
For neutron application the default EPS is "Neutron1".

The Radosys software provides also the feature of a custom-made EPS with individual parameter settings. To construct a custom-made EPS, select any of the existing EPS, being a sample style, and click on the "Edit" button. The individual parameters can be edited and stored with a different EPS name. Please go to "Edit Parameter Set" subtitle to get more information about the details.

Click on the "OK" button to start the measurement with the simplest way. However more options are available, as follows.

5.4.2.1.5 OK button

Click on this button to start the analysis of a single detector holder card. The analysis will be conducted on the inserted card according to the current EPS.

5.4.2.1.6 Batch button. (This button is not available at the RSV60 version)

Click on this button to start the analysis with repeated card insertion. This option can be applied when more cards are desired to be evaluated with the same EPS. This is the most convenient way when a significant number of detectors are desired to be analyzed. Once the analysis on the previous card finished, the next card can be inserted without any repeated parameter settings, and the next card is analyzed with the same EPS. Of course, each card will be furnished with new card ID automatically. Probably this mode will be applied the most frequently in a lab, where the detectors are processed regularly and with big quantity.

5.4.2.1.7 Loop button.

Click on this button, when a repeated analysis of the same card is desired. The analysis of the current card is repeated as long as until the action is stopped. This mode is recommended for demonstration operation only. This is not recommended for real measurement, since any accurate measurement requires a brightness calibration at each start of the inserted card. This brightness calibration is done at each insertion of a new card, however it can not be invoked whenever the card stays in the card tray without removal.

5.4.2.2 Edit Loadlist

This window is displayed when the option "Specify IDs and positions" was selected in the window "Automatic Measurement" and one of the measurement starting buttons was pressed.

Using this option it is possible to enter and define the detector's ID individually. If an ID field remained empty, the ID will be defined by automatic code reading.

It is also possible to assign EPS to each detector individually.

When the detector selection checker is off, this detector position will not be measured at all.

Individual comments can be also added to each detector position.
- To do so, drag the mouse pointer above the checker or the EPS field of the given detector position; or click on its ID edit field.
- Afterward click on the comment field; ("Comment for det. nn", where nn denotes the desired position number.) During this operation do not drag the mouse pointer above the checker or EPS field of any other detector position to avoid altering the position selection.
- You may check the validity of the position selection by the information displayed left to the comment field.

After editing the loadlist the measurement can be started by the button OK. Or to void all the edit operation, click on the button Cancel.

5.4.2.3 Track Marks

Soft key combination: Ctrl+T

Description: Recognised alpha tracks are marked with circles in red

Usage: Select this option to set the display status of the main window in order to display the marking of the recognised tracks. These marks are in correspondence with the objects, which were qualified by the software being a recognized alpha track. The track marks are red circles around the object. Select the marker again to deselect this option. The corresponding shape of the marker beside of this menu title indicates the actual

status of this option. The software preserves the last setting of this option even after restarting the system.

The "Live picture" and the "Track marks" options are their each alternative. These two alternative options can not be applied the same time.

5.4.2.4   Live Picture

Soft key combination: Ctrl+L

Description: Live microscopic image is displayed in the main window continuously.

Usage: Select this option to set the display status of the main window in order to display a live camera picture, like a real–time microscope image display. Select the marker again to deselect this option. The corresponding shape of the marker beside of this menu title indicates the actual status of this option. The software preserves the last setting of this option even after restarting the system.

Notes: Occasionally, it may happen that the displayed image seems not well contrasted in live mode. This does not mean that the image analysis itself is conducted by means of the displayed live picture. The analysis is always done with an image with high contrast, according to the automatic focus operation in the background. The point is that these two processes, the image captures for the analysis and the image displaying, are not connected to each other tightly. The image analysis is a faster process than that of the image display. Therefore sometimes the image displaying process may delay, while the image analysis itself is done correctly at the background. The point is that the image analysis has the highest priority among the processes running in the computer simultaneously.

The "Live picture" and the "Track marks" options are their each alternative. These two alternative options can not be applied the same time.

5.4.2.5   Drop Slide

Soft key combination: Ctrl+D

Description: Removal of detector holder card from the microscope

Usage: Use this menu item to remove a detector holder card from the microscope.

Warning!
This command is not available during Automatic Measurement.

Note: If the "Auto Drop Slide" option in the Maintenance/Settings menu was switched on, this command will be executed after completion of any started Automatic Measurement session automatically.

5.4.2.6   Feed Slide

Soft key combination: Ctrl+F

Description: Insertion of detector holder card into the microscope

Usage: Use this menu item to insert a detector holder card into the microscope. After invoking this command, the software conducts an illumination process, which may take a few seconds. Afterward, the microscope places its card feeder to its feeding position. A message window with the text of " Please insert next slide" is displayed. Should this operation were no longer needed, just click on the Cancel button and the microscope will return to its default state.

Note: Whenever a measurement is started, either at Automatic or Manual Mode, the software checks the existence of the holder card in the microscope. If no any inserted card is detected, the "Feed Slide" command will be invoked automatically.

Tips: Sometimes it might happen that the main window is clicked before the insertion. This accidental action will cause the message window to get to background position. This occurrence is normal, and this is the behavior of any windows-like systems. This occurrence can be corrected by the next ways.
Insert the card to the microscope.
Or drag the mouse pointer to the top of the screen and select the "Radometer message" item.

5.4.2.7 Save Picture

Soft key combination: Ctrl+S

Description: Saves the image of the main Radosys window to a local file in JPEG format.

Usage: Select the image is desired to save by means of the Manual Mode. Select this menu of "Save picture". Select the folder, where the image file should be stored, among the options displayed in the dialogue window. Enter the filename together with the file extension into the input field at the bottom of the window.

Warning
The work folder of the Radometer software (/radosys/RadoMeter/bin) is not accessible for file storage. Please select another folder, for example the folder of the "rm" user ((/home/rm) or any subfolder of this.

Options:

With header: Some specific information related to the nature of the image can be stored together by displaying on the saved image. The desired information to be displayed is selectable. The next information is available to be included.

- Detector ID code
- Date and time of the image record.
- The relative XYZ position of the optics head corresponding to the image capture.

With track marks: The track marks can be also stored together with the image. These marks are in correspondence with the objects, which were qualified by the software being a recognised alpha track. The track marks are red circles around the object.

JPEG quality: This is a setting option for the desired quality and compression mode of the stored image. Bigger numbers provide higher quality, but bigger file size consequently.

5.4.2.8 Exit
Soft key combination: Alt+X

Description: Stops the measurement and quit the software.

Usage: Use this menu option after the completion of the measurement and before the powering off the equipment. The same function is available by clicking on the "night-time" icon on the Taskbar. Whenever a detector holder card is still inside the microscope, the software recognizes this status and displays a message requesting confirmation. According to the nature of the decision, one of the next will be happened.

The holder card can be removed by a direct command (Drop Slide selection). A repeated execution of the Exit command is needed at this case.

Exit was selected. This case the holder card will stay in the Microscope and this will be removed at the next start automatically.
The query for the exit operation can be cancelled by Cancel selection.

Warning

After exit from the software, the computer must not powered off immediately. To switch off the computer please follow the next instruction.
Close the X-Windows graphics environment by selecting Logout in the "K" menu at the taskbar.
Invoke the "Shutdown" operation in the displayed window.
Wait until the massage "Level 0 reached" is displayed.
Push the main power button of the computer.

5.4.3 EVALUATION PARAMETERS (RS-RM VERSION SOFTWARE)

A huge amount of optional parameters can be set in the Parameters window.
This window is available in the window "Automatic Measurement", when the button "Edit" is selected in the line "Parameter Set"

This description is valid for the RS-RM version software version only, which is dedicated to radon application. At the RS-TA version software, which is dedicated to neutron application and to general track research, the meaning of a few options is different. The RS-TA software specific options are described in a separate chapter.

A few Parameter Settings options were developed during the evolution of the Radometer application and it may happen that those have lost their importance in the meantime. But we have not yet cleared them, since we wanted to keep them for further research. Most of those research options are also described here. But as a general guidance, it is noted that the most comprehensive options, which has "survived" the evolution of the Radometer software, comprise the basis of the standard EPS sets, which are installed together with the recent versions of the system.

It is especially noted that the Track Type Options at the RS-RM software is not documented in details, and just a rough description is provided to get impression about their functions. This lowest level operation of the track recognition algorithm is considered being intellectual property by the Radosys Ltd. Therefore just a rough description can be provided here.
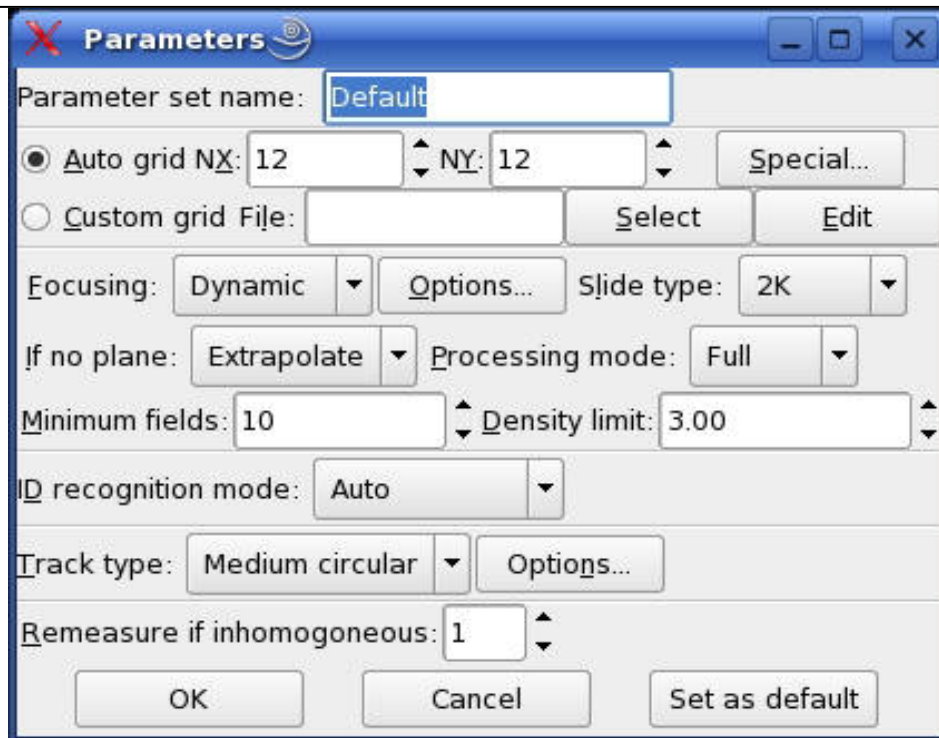
The Parameters Window

Track Type Options
Description of the deepest level Track Recognition control parameters

Shift, Limit, Cut parameters control the recognition of border-points of an object.
These parameters determine the criteria of acceptance for a border point of an object.
If one of two points at a distance SHIFT performs light intensity less than CUT, and the difference of intensity exceeds LIMIT, that point is a recognized point belonging to the border of the object.

No-of-points, R-max, R-min parameters control the recognition of a track.
These parameters determine the criteria of acceptance for a track on the basis of the formerly recognized set of border-points.
If the object has No-of-points number of border-points at least, when a matching ring including those border-points exists, and the smaller/bigger radius of the ring is R-min/R-max, this object will be a recognized track.

Overlap parameter controls the recognition of overlapping tracks.
The centers of two tracks can not be closer to each other than a distance of Overlap, which is a measure in pixels.

5.4.4 *EVALUATION PROCESS VISUALIZATION, THE PROGRESS WINDOW,(RM-V3 VERSION)*

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The process of the evaluation can be tracked by the Progress window.
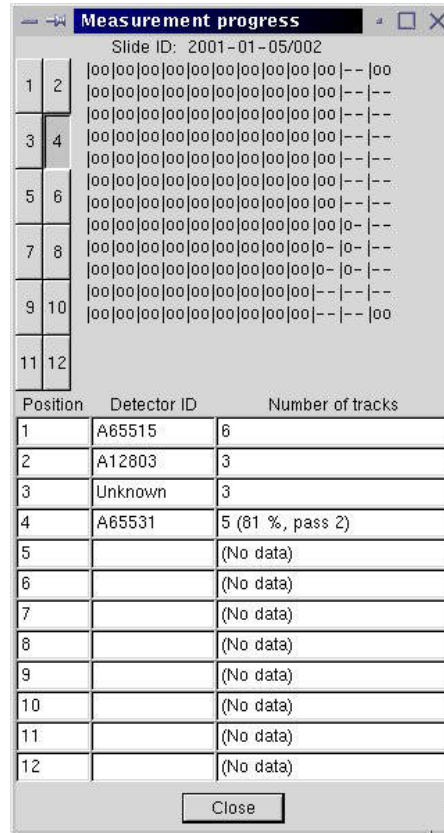
Soft key combination: Ctrl+P

Description: Displays the measurement progress window.

Usage: Normally, without the application of this option, the basic information about the measurement progress is displayed at the bottom line of the main Radosys window. Use this option to display additional details about the progress. The "Progress " window is displayed after the selection of this menu item. Select the marker again to deselect this option. The corresponding shape of the marker beside of this menu title indicates the actual status of this option.

There is a rectangular field equally divided to 12 lines at the lower part of the progress window. These 12 lines represent the detectors in the holder frame. One of them is highlighted that one is under analysis at the moment.
There is a rectangular field at the top area of the window, which resembles a matrix. Each section of this matrix corresponds to an individual view-field of the microscope. During the analysis, these view-fields are scanned systematically, by means of a sophisticated scanning algorithm. The same time the analysis status of each field is indicated within the matrix by means of a specific codification.

The basic rule of this codification is the next.

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The view-filed is marked by

.. the character "-" where scanning operation is due later

.. the character "o-" where the optimal focus plane has been already determined, but the track analysis is due

.. the character "oo" where the analysis has been already completed

Information about the recognized detector ID codes, together the counted number of tracks, also about the analysis status per each detector are displayed in the 12 lines.

5.4.5 SLIDE EDIT OPTION

The Radometer Analyzer manages the identification of the detector holders and of the detector chips automatically. However this can be overridden by the user for any particular purpose.

Please remember what sequence the detector chip positions within the holder are registered by the analyzer.

5.4.6   GLOBAL RADOSYS SOFTWARE OPERATION SETTINGS

The Settings Window.
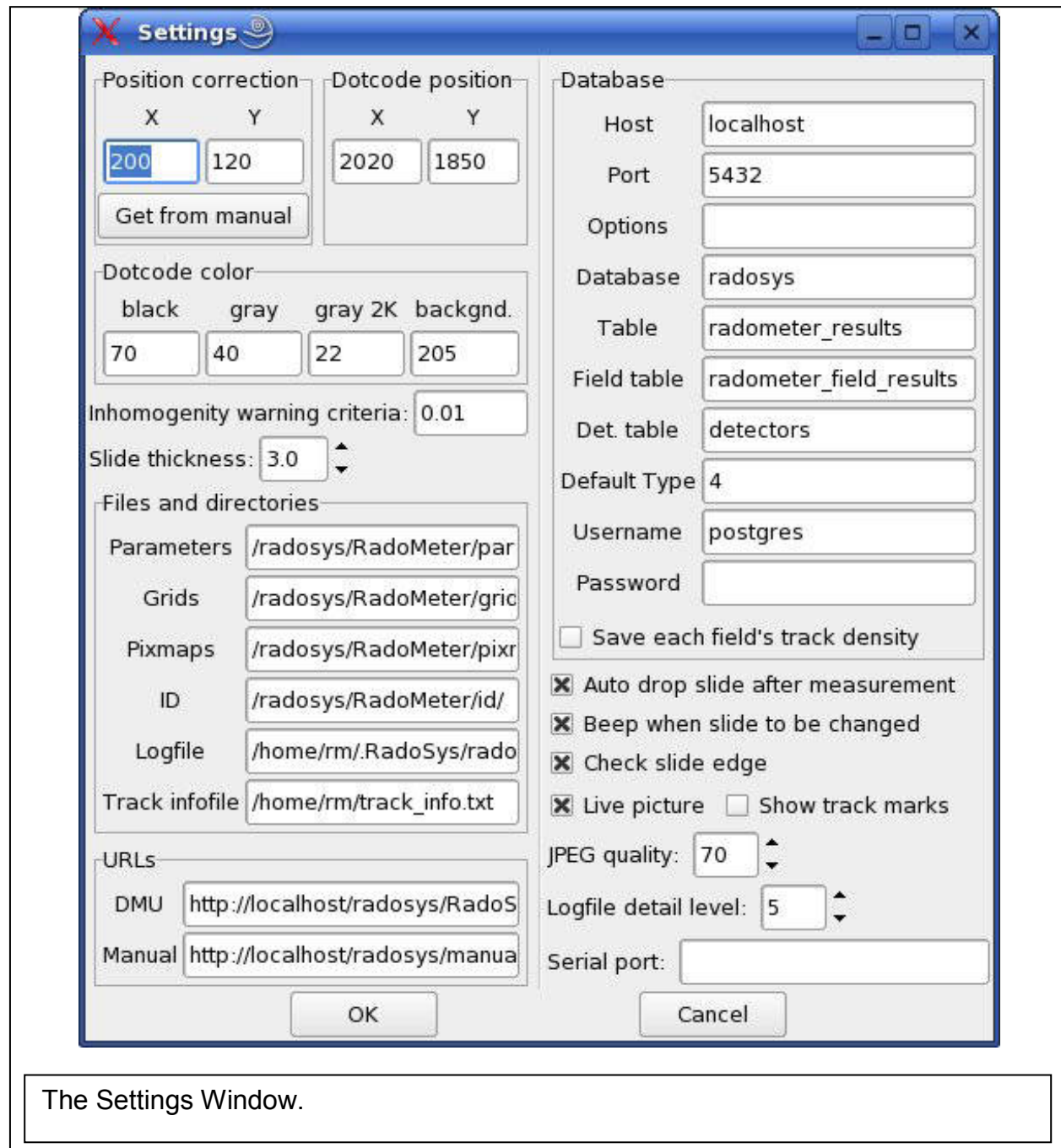
5.4.7 MANUAL CONTROL OPERATION

A special mode of operation is also available, where the Radosys microscope can be used also like a normal lab microscope. But this time the controls are available from the Radometer software environment. Additionally, all the Radometer specific, track reading application features are also available to control by means of control buttons.

The Manual Control Window. This is available in the Measurement menu.
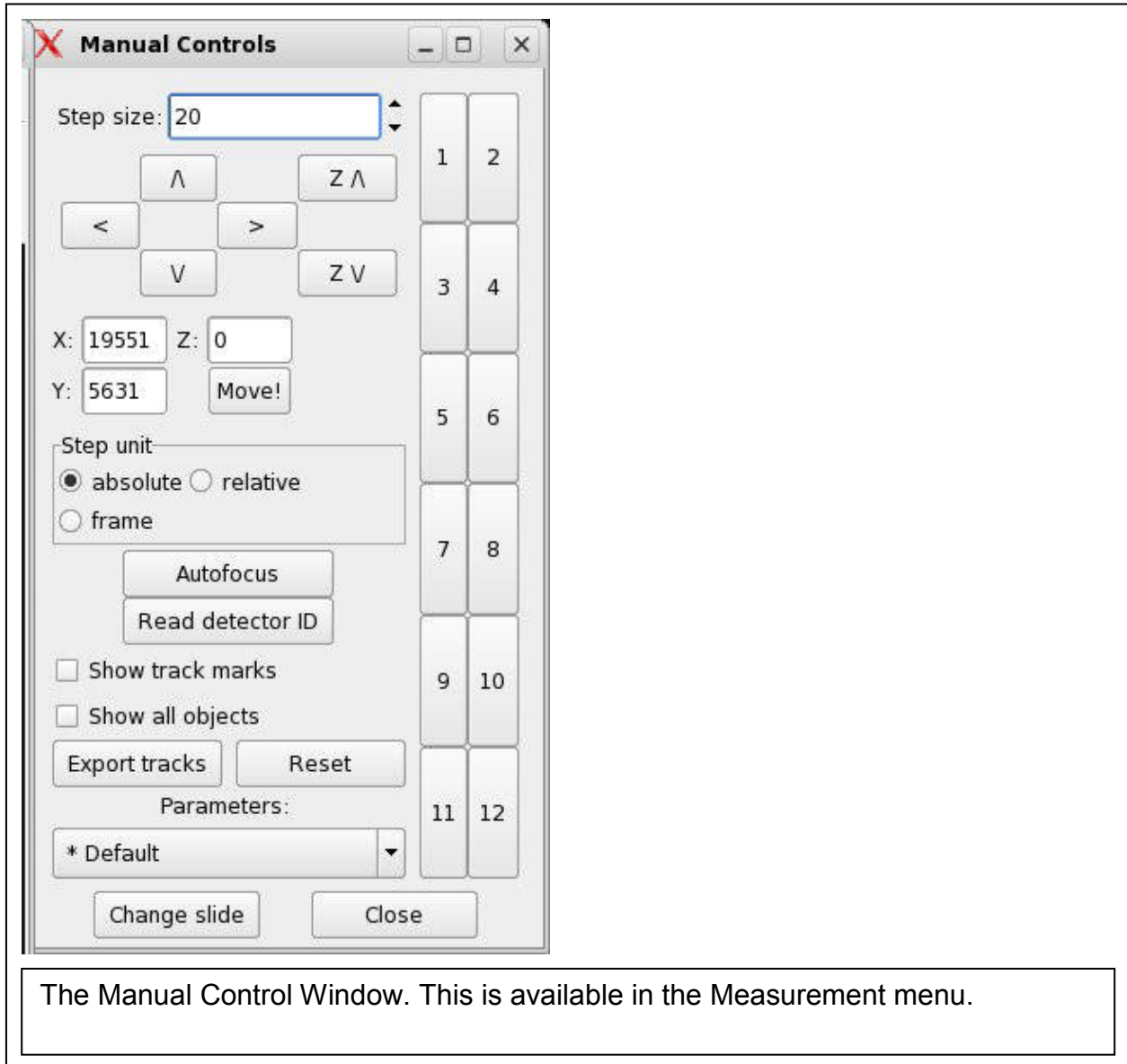
5.4.7.1 General and Common Note about This Feature

The optics head of the microscope can be controlled manually. This means that the microscopic objective can be moved along the X-Y plane of the detector chip by means of movement keys or buttons. These movement control buttons are displayed at the top area of the "Manual Controls" window. Each selected stepping mode instructs the software to conduct different way of movements at the microscopic head, concerning to the unit of the movement, as well as the displayed X-Y position value. There are also *X:Y position indicator fields* in order to display the actual position value of the optics head. The unit of the displayed value equals to the stepping number of the corresponding directional movement stepper motor. However the meaning of the value displayed in the position indicator fields may depend on the selected "step mode".
The default setting of the step-mode is "absolute".

5.4.7.2 Manual Measurement

Soft key combination: Ctrl+M

Description: Operational mode to control the microscope manually, like a conventional microscope, but the interaction is made by means of set of software tools provided by a graphics window. This mode is also applicable for visual evaluation of the microscopic view-fields.

Usage: Select this menu option and insert the detector holder card into the microscope. A window with the title of "Manual Controls" is displayed. Wait a few seconds until the automatism of the microscope moves the card into its steady position.
A set of manual control features is available, as follows.

Selection one of the detectors in the card: 12 detectors are included in one holder card. Each detector can be selected by clicking on the desired detector position illustrated at the right edge of the window, by a matrix of numbered buttons.

Choice an X-Y stepping mode, referred as "step mode": Three different modes are available, namely either of "absolute", "relative" or "frame".

5.4.7.3 "Frame" Step Mode

At this mode, not the cumulated number of the directional movement motor steps are displayed in the *X:Y position indicator field*, but the sequence number of the view-field displayed in the main microscopic image window. The target feature of this mode is to provide the opportunities of stepping from view-field to view-field by manual control, comprising those view-fields exactly, that are the subjects of the evaluation in "Automatic Measurement Mode". The numbers displayed in the *X:Y position indicator field* correspond to the sequential number of the column and row of the view-field within the detector chip.

Warning! The operation of this mode depends on the applied *evaluation parameter set*. The actual set of view-fields are influenced on the settings options. Please find the related information below.

Notes: It may happen that some difference occurs between the microscopic images at automatic and manual mode, or at repeated measurements. However any significant difference can be expected only if the *applied evaluation parameter set* had changed.

Notes: At alteration to mode of relative or of frame style, the ID code of the detector chip is recognized automatically. Consequently, the exact position of the detector chip within the holder card is recognized at the same time accurately.

5.4.7.4 "Relative" Step Mode

This mode is similar to the "Absolute" step mode, but there is a difference. The origin of the coordinate system is located to a specific position of the selected detector chip. This origin is located at the most upper left position of the evaluation area of the detector chip.

5.4.7.5 "Absolute" Step Mode

Data displayed in the position indicator fields corresponds to the absolute, hardware related coordinate system of the microscope itself. The indicated unit corresponds to 4 microns in the X-Y plane. The indicated unit corresponds to 0.05 microns in Z-direction.

Explanation for the direction denotation:

X-Y Plane: Plane, which is parallel with the surface of the detector chip. The origin of the absolute coordinate system is located at the most upper left position of the holder card, which is marked by a 45 degrees slope on it. X-axis is the longer and Y-axis is the shorter one.

Z-direction: Z-position value corresponds to a perpendicular distance from the surface of the detector chip. Zero position denotes the biggest distance from the chip.

5.4.7.6 Other Buttons and Editable Fields

Setting the movement step unit: This field is editable or a few predefined values are selectable by the scroll bar. In "absolute" or "relative" mode this value determines the size of one step, which is expressed as a number of the elementary steps made by the directional movement stepper motors in X or Y direction. This field is not meaningful in "frame" mode, since at this mode the unit step is 1, and this value can not be modified. The value of this field also determines the unit steps towards the Z-direction. The Z-directional stepper motor makes as many elementary steps, as the double of the number in this field exactly.

Direct movement of the directional stepper motors: This tool is controlled by the set of buttons, like the cursor movement keys of the keyboard. This buttons indicated by arrows at the top of the window. The movement towards the Z-direction, that is the tuning of the contrast, is made by clicking on the buttons indicated by "Z^" and "Zv". The alternative mode for the control is the usage of the cursor movement keys of the

keyboard, if the keyboard was set to NumLock state previously. If this control mode were applied, this would be effective only if the cursor was not active in a data enter field.

Direct movement to the desired location: Select the desired stepping mode and enter the target location into the X/Y/Z fields. Click on the "Move!" button.

Warning! It may happen that the objective of the microscope bumps to the detector chip or to the holder card during its control towards the Z-direction. This state can be recognized easily by watching the microscopic image main window. If the image does not perform any change, in spite of the repeated instruction for Z-directional movement, this will be a good indicator of this bumping state. The mechanical structure of the microscope ensures protection against this event, because of its flexible suspension. However please avoid invoking any X/Y movement instruction at this bumping state in order to protect the front lens of the objective against damaging scratches.

Reading the ID code of the detector chip "Read ID": Click on the button. The reading operation starts and after a few seconds the result of the reading will be displayed in a message window. The message informs about the recognized ID code.

Automatic image contrast query ("Autofocus"): Click on the button in order to instruct the software to carry out the automatic microscopic image focusing.

Notes: The Z-directional position decided being optimal by the auto-focus operation is influenced on the actual settings of the evaluation parameter set.

Alteration of the microscopic enlargement: Beside the standard 100x enlargement, the opportunity of 400x is also available at a few Radosys Microscope units. This feature is provided by the microscope hardware, but this option is meaningless at the current Radosys evaluation software. Click on the button to achieve a bigger enlargement and click on again to return to the standard mode of 100x.

Note: The feature of 400x enlargement is not available at all Radosys microscopes, but only at a few delivered units.

Replacement of the holder card: Click on this button in order to change the holder card with the detectors to be analyzed. A message window will instruct about what to do.

Close the window ("Close"): After the manual analysis, the window can be closed by the selection of this menu option. The analysis software gets into it standby state and gets ready to carry out the next instructions, for example, invoking automatic analysis or manual operation with the next holder card.

5.4.8 CALIBRATION PARAMETER SETTINGS

5.4.9 DEBUG WINDOW

```
■ –⋈ /radosys/RadoMeter/bin/rm                          ◢ □ ×

   File  Sessions  Options                                Help

sd_focus: calling focus                                        △
FOCUS_LINE: 1 (6281)
sd_focus: calling focus
FOCUS_LINE: 1 (6143)
sd_focus: calling focus
FOCUS_LINE: 2 (6157)
sd_focus: bad, calling FIRST_FOCUS
FOCUS_FIRST: 1 (6333)
sd_focus: calling focus
FOCUS_LINE: 1 (6387)
sd_focus: calling focus
FOCUS_LINE: 1 (6389)
sd_focus: calling focus
FOCUS_LINE: 1 (6347)
sd_focus: calling focus
FOCUS_LINE: 2 (6361)
sd_focus: bad, calling FIRST_FOCUS
FOCUS_FIRST: 1 (5919)
sd_focus: OK, calling focus again
FOCUS_LINE: 1 (6407)
█                                                              ▽
```

5.5   RADOSYS DMU SOFTWARE ADVANCED OPERATION

5.5.1   WARNING AND ERROR CODES

Error code	Description
-1	ID not found
-2	Empty position
-3	Error in code
-4	Corrected code
-5	ID not in allowed range
-999	ID not in allowed range
-998	Lentgh of ID is too short
-997	Key of the detector is not valid
-996	PGP keyring error
-995	Temporary file creation error
-994	Pipe error
-993	Error in communicating with database server
-992	Database server returned SQL error

ID Code Reading Related Error Codes

5.5.2   DESCRIPTION OF COLUMNS IN DMU RESULT CHART

Description about the available columns listed in the result chart is available in the Chapter 5.5.3. The same set of columns and concept has been implemented in all the versions of the Radosys DMU software.

This equivalence among the versions is specific to the result columns only. In other respects those versions are different and the later DMU-V6 version provides a few extra features, which is not available at the former version DMU-V3. But these extra features are not related to the result columns. Therefore the available result columns can be considered universal along the various DMU software versions.

5.5.3   DATA LISTING WITH THE DMU SOFTWARE

The Radometer software stores a lot of various data in the database during the analysis of a detector chip. A part of them provides the most relevant results but the majority are used occasionally, mainly for diagnostic purposes.

By default only a set of the most relevant results is accessible. However, by clicking the "Configuration" button on the bottom part of the window, another window will appear with the full set of stored data types (see figure of "Parameter Chart"). By means of this list the result chart can be freely designed by the user. Each item in the list consists of the abbreviation of the requested data column and a check box, which can be altered by

clicking on it. If the check box is checked, the corresponding column will be included in the result chart, otherwise it will be excluded.

Four preset configurations are available:

Default: items considered most common in practice are checked

All: (almost) all listed items are checked

Exposure: in addition to the parameters in the Default configuration it contains the exposure time and the radon concentration but does not include the Paramset

Dates: in addition to the parameters in the Exposure configuration it contains the first and last day of exposure but does not include the dose.

Each of these configurations can be altered by checking the check box next to the appropriate items and then clicking on the "Save" button. Moreover, new configurations can be added by clicking the "New" button. Then in the pop-up window enter a name for the new configuration and press Enter. Any configuration can be deleted by choosing the configuration and pressing the Delete button.

You can also change the order of the listed items by clicking the "Configure List Order" button. In the pop-up window the selected parameters are written in black, the deselected parameters are written in red. You can move each item up and down by clicking the "Up" and "Down" buttons. Click OK.

You can close the Configuration window by clicking the "Close" button (see below).

The available stored parameters in the DMU software - "Parameter Chart"

The list of the available columns together with a brief description is as follows.

Parameter	Description
Result_ID	Serial number of the result
Date & Time	Date and time of the analysis in format YYYY-MM-DD hh:mm:ss
Date	Date of the analysis in format YYY-MM-DD

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Parameter	Description
Detector ID	Identification number of the detector
Detector ID mode	Status of the detector's ID code reading. Value "A" means Automatically Recognized, value "B" means Manually Entered and value "C" means Automatically Recognized with the possibility to manually correct the falsely identified ID codes.
Slide ID	ID code of the corresponding slide
Position in slide	Position number of the detector chip in the slide. Its value falls between 1 and 12.
Automatic grid	Status of the scan grid. "+" means Automatic Grid, "-" means User Defined Grid.
Grid start X, Grid start Y	Starting location in the X and Y directions counted from the upper left corner of the detector chip in units of the stepper motors*
Grid delta X, Grid delta Y	Step size between neighboring view-fields in the X and Y directions in units of the stepper motors*
Grid number X, Grid number Y	Number of view-fields to X and Y directions*
Position file	When User Defined Grid is used, the name of the definition file is listed here.
Focus mode	Various modes of auto-focus operation are available. This value provides information on the utilized mode. Values A, B, C, D mean Dynamic Mode, Focus All Mode, Fixed Mode, Engraved Mode, respectively.
If no plane found mode	Auto-focus strategy applied when the standard auto-focus operation failed at a given view-field. Value "A" means Extrapolate Mode, value "B" means Focus All Mode.
Track mode	Applied track type. Values A, B, C, D mean Small Circular, Medium Circular, Large Circular and Custom Circular, respectively.
Processing mode	reserved for future use
Number of fields	Total number of view-fields scanned, which contribute to the track density result. Failed view-fields are not counted. Remark: In Repeated Mode the total number of scanned and contributing view-fields is displayed.
Size of area (mm2)	Total scanned area that contributes to the result expressed in tracks/mm^2. Remark: In Repeated Mode the total sum of scanned area is displayed that contributes to the result.
Number of tracks	Total number of counted tracks. Remark: In Repeated Mode the total sum of counted tracks is displayed that contribute to the result.

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Parameter	Description
Track density	Track density in tracks/mm^2. If the detector was analysed in Repeated Mode then the mean of the read track densities is listed here.
Mechanics ID	ID code of the microscope unit, by which the measurement was carried out.
Software version	Version number of the RM software, by which the measurement was carried out.
Flags	Auxiliary descriptive information about the analysis.
Operator's username	ID of the LINUX user, who invoked the RM software.
Comment for measurement	A comment entered at the time of the analysis.
Standard deviation	Standard deviation of the repeated scans in Repeated Mode. This has no sense when the detector is scanned only once (Passes = 1), in which case 0 is displayed.
Count of measurements	This is the number of measurement cycles in Repeated Mode.
Slide type	Type of the applied slide. Value "A" means Normal Slide and value "B" means 2K Slide.
Saturated	Indicates whether or not the detector chip was saturated with tracks. For a detailed description please refer to the related section of this Manual.
Ratio of dark points	Percentage of the dark pixels relative to the total number of pixels. The saturation condition is detected by means of this value.
Z offset	The actual, optimal focus plane where the track recognition is carried out, which may differ from the focus plane determined by the auto-focus operation itself. This value provides information about the distance between the focus plane of the track recognition and that of determined by the auto-focus operation.
Focus plane DZ2 value	A score value of the accuracy of the auto-focus operation. Smaller values indicate more accurate fitting of the focus plane.
Detector has detailed data	Indicates whether the number of tracks in all view-fields has been stored separately.
Maximum track density	If the detector was analyzed in Repeated Mode (passes > 1) then the maximum track density is listed here.
Inhomogenity value, Inhomogenity P value	These values are provided by the statistics analysis carried out to detect inhomogeneous distribution of tracks along the scanned area. For more details of this analysis please find information in the corresponding chapter of this Manual.

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Parameter	Description
Inhomogenity check failed	Indicates whether the distribution of the tracks on the chip is inhomogeneous.
ID reading error code	See 5.5.1.1.
Detector has class data	Indicates whether the track size distribution has been determined for the detector.
Paramset	Name of the parameter set used for the measurement.
Paramset ID	Numeric ID of the parameter set used for the measurement.
Correction factor of microscope	If the results of the microscope systematically differ from those of the reference microscope then a correction factor is used to correct the track densities when calculating the exposure and radon concentration values. The listed track density is the originally read track density.
Detector ID	Identification number of the detector.
First day of exposure	First day of the exposure.
Last day of exposure	Last day of the exposure.
Calibration set ID	Calibration set assigned to the detector. It is 0 in case of automatic assignment.
Comment for detector	Additional comment assigned to detector.
Detector type (numeric)	Numeric code of the diffusion chamber.
Linked detector ID	In case of a double chip diffusion chamber, the identification number of the other detector chip is displayed here.
Key	reserved for future use
Exposure time (days)	Duration of the exposure of the detectors in days.
RAC in Bq/m3 units	Radon activity concentration in Bq/m^3
RAC in pCi/l units	Radon activity concentration in pCi/l
Exposure (kBq.m-3.h)	Radon exposure that the detectors have been exposed to
Detector type	Type of the diffusion chamber.

* These parameters have a meaning only in Automatic Grid mode and provide information about the scan grid.

5.5.4 DATA EXPORTATION TO OTHER APPLICATIONS

The result chart of the DMU software can be transferred for use by another application in two steps. In the first step the chart is exported into a text file. In the second step the text file is imported to the other application, which is usually Microsoft Excel.

In the following two subsections the data exportation and the text file importation for MS Excel is described.

5.5.4.1 Data Exportation From DMU-V6R or DMU-V6N Software Versions

To create the export text file follow the steps below:

1. Compose your result chart as described in section 5.5.3.
2. In the bottom right corner of the window you will find a group box called "Filter", where you can filter the items to be listed on the screen.
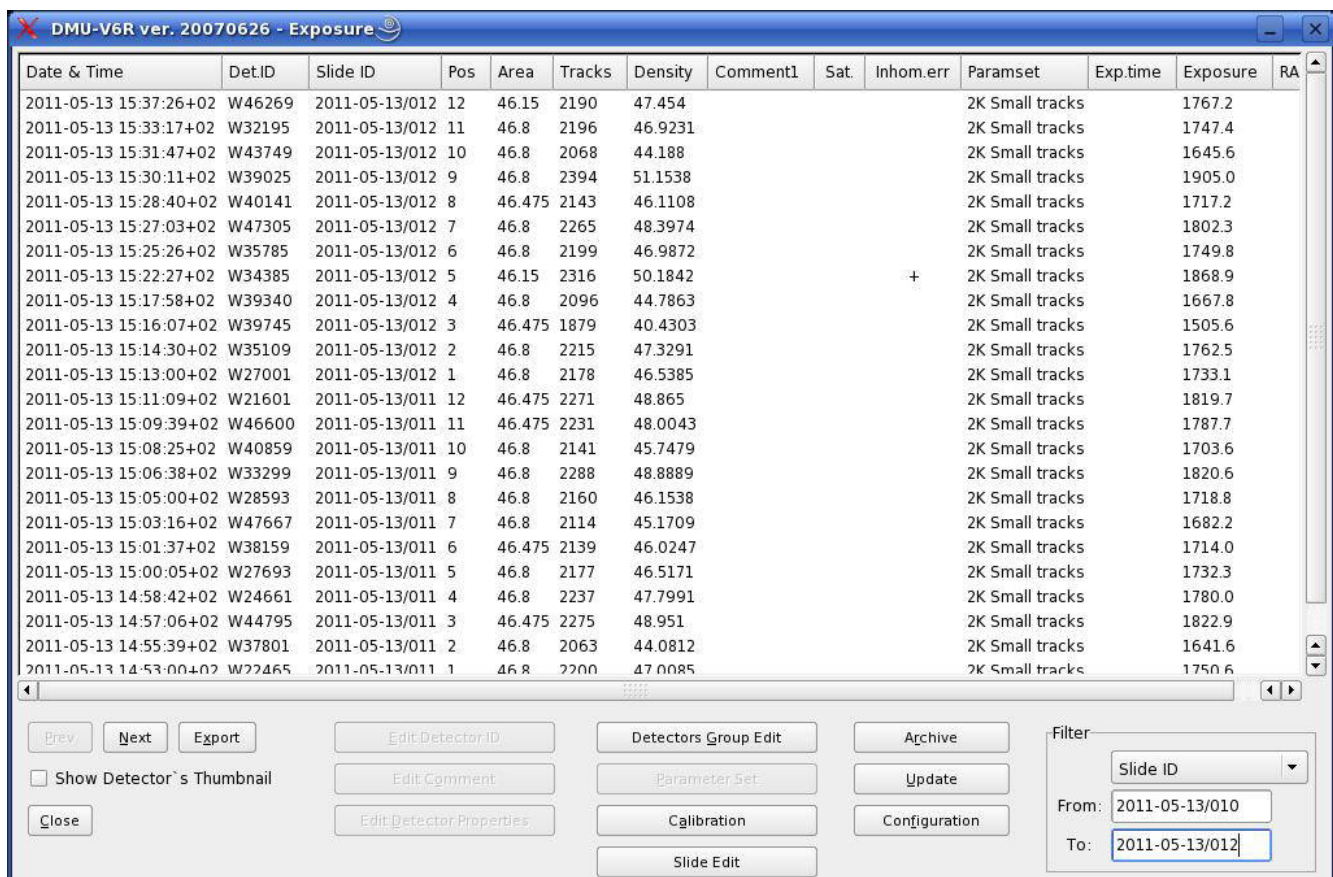
The DMU results screen filtered by the Slide ID

3. Select a parameter in the drop down list, according to which you want to filter the listed items.
4. Enter the initial and final values for the selected parameter. If you omit the final value then it is assumed to be equal to the initial one.
5. Now only the results corresponding to the above settings will be listed. 25 rows can fit in one window. You can move in the list by pressing the "Prev" and "Next" buttons.

6. Press the "Export" button. A pop-up window will appear.

The export window of the DMU software

7. If you have plugged in a pendrive then it will appear in the "Save in folder:" field by default.
8. Enter a name for the exported file. The default file name is export.txt. It is recommended to use a txt extension.
9. Select the folder you want the exported file to be saved into.
10. If you check the "Export Filtered" check box then only the filtered results listed on the screen will be exported. If you check the "Export All" check box then all the results will be exported.
11. Click on the OK button.
12. The exported file will have a semicolon (;) delimited format.

5.5.4.2 Data Exportation From DMU-V99 Software Version

In order to import the exported text file to MS Excel, follow the steps below:
1. In MS Excel select the command Open.
2. In the Open window, at the line <File of Type> select Text Files.
3. Select the exported text file and click on Open. A three step dialogue <Text Import Wizard> will start.
4. In the window Step 1 of 3 of the Wizard mark the Delimiter option and click on the Next button.
5. In the window Step 2 of 3 of the Wizard mark the Semicolon option and click on the Next button.
6. In the window Step 3 of 3 of the Wizard there is nothing important to do, just click on the Finish button.

5.5.4.3 MS Excel Specific Notes

When regional language version of the MS Windows is used, it may happen that the imported chart behaves unusually.

For instance it may happen that a cell with seemingly decimal number in it does not behave as decimal number.

Whenever this or similar happens, it is recommended to check a few tips as follows.
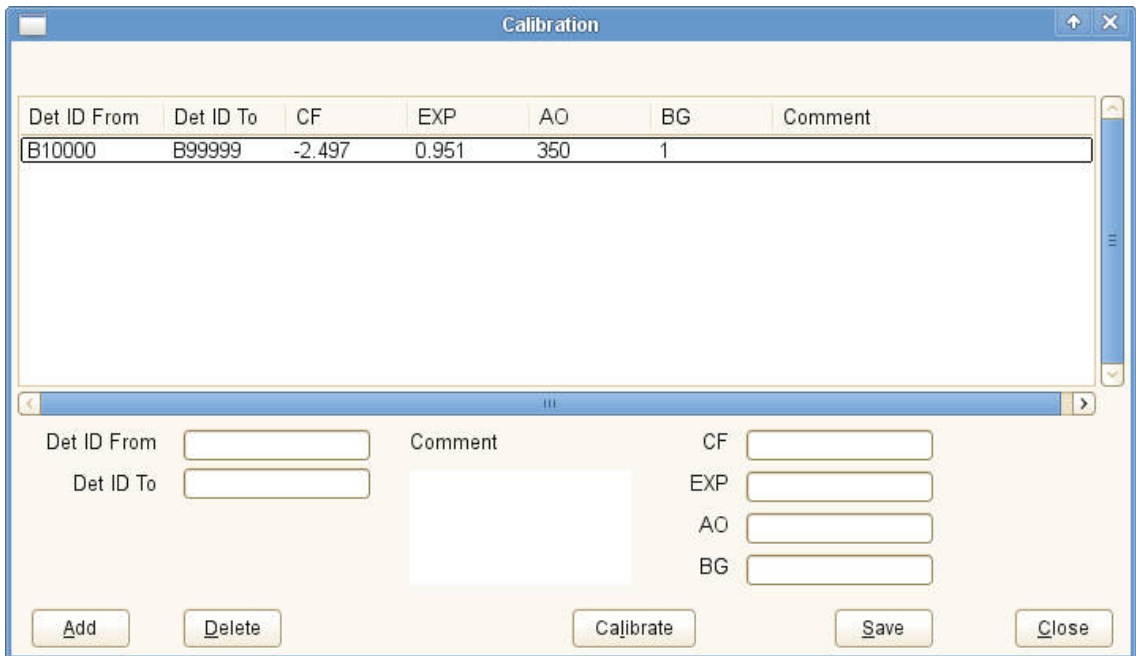
- Check the format of the cell and correct the format to the appropriate one.
- Check the regional settings of your Windows. In many regional versions the decimal point is not a period but a comma.

5.5.5 *CALIBRATION USING THE DMU-V6R SOFTWARE BEFORE OCTOBER, 2012.*

Read this chapter at DMU sw versions installed before 15, October, 2012. For later sw versions read Chapter 5.5.6.

In order to perform an analysis of the calibration results follow the instructions below:

1. Measure the calibration detectors normally.
2. After each calibration detector is evaluated successfully, switch to the DMU-V6R software and push the [Calibration] button on the main screen. The Calibration window with a list of the current calibration factors will appear.

The calibration window of the DMU software

3. If you want to modify a previous calibration, then choose the corresponding line. Alternatively fill in the "Det ID From", "Det ID To" and optionally the "Comment" fields. However, you can also leave these fields empty at this stage.

4. Push the [Calibrate] button. In the next window a list of recently measured slides and an empty graph will be displayed.
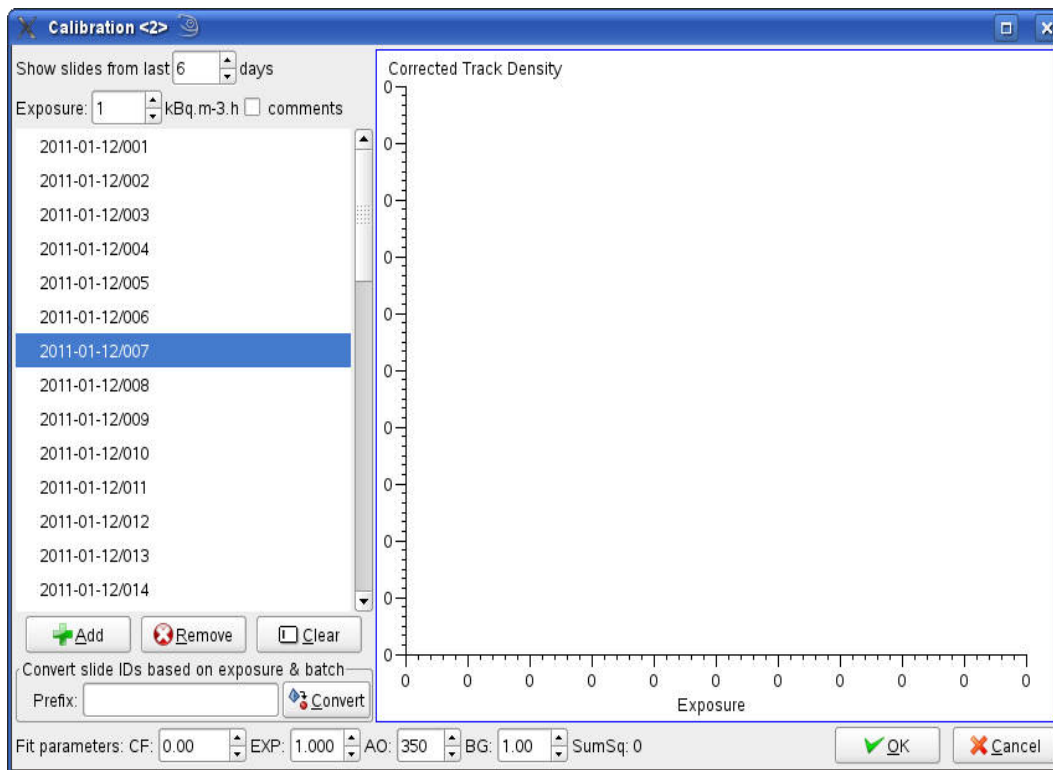
Table ZX, The calibration results window of the DMU software (with an empty graph)

5. In this window you can see a list of detector batches. Each batch contains detectors that were exposed to the same level of exposure. Entering a number in the "Show slides from last *N* days" control, you can set the time period in which the batches to be displayed in the list were analysed.

6. If you want to see the comments on the slides instead of the slide IDs then check the "comments" check box.

7. Select a batch by clicking on it. If more than one batch belong to the same exposure group then you can select them all by holding down the "Ctrl" key while clicking them one by one. If there are several slides with the same comment (e.g. CAL144) then one line in the list will cover all the detectors in that exposure group, so it is sufficient to choose only one line per exposure group.

8. Enter the exposure value for the selected batch in the "Exposure:" field. If the "Slide ID" or the "Comment" field contains the string "CAL" followed by a number, then this number indicates the appropriate exposure value in the unit of kBqh/m^3, which is automatically copied to the "Exposure:" field. (For example, if the "Comment" field contains "CAL144" then the exposure is equal to 144 kBqh/m^3, which is automatically copied to the "Exposure:" field.)

9. Click the [+ Add] button. The corrected densities of the detectors within the selected batch will be plotted on the graph in red.

10. Repeat steps 7-9 for each exposure group.

11. The background value will be automatically calculated from the group with 0 exposure.
12. The CF and EXP values are calculated from a power function fitting on all the selected exposure groups.
13. The AO parameter is preset, it should not be changed.
14. If the result of fitting is not satisfactory, each parameter can be adjusted manually.
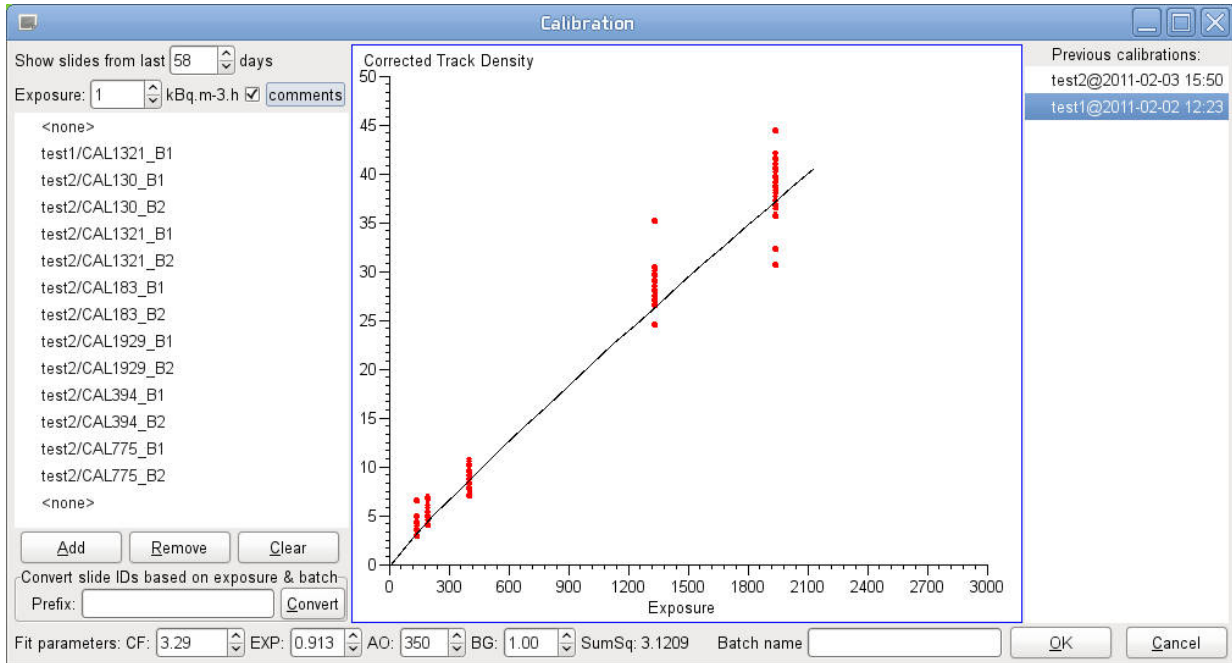
The calibration results window of the DMU software (with the fitted curve)

15. Enter an identifier in the "Batch name" box next to the ⏎OK button. This can be used to look up this calibration later.

16. The parameters can be accepted by clicking the ⏎OK button. The calibration is saved as "batchname@current-date-and-time" and can be seen at the top of the "Previous calibrations" list on the right hand side of the window.

17. At the same time the program will generate an XLS file that contains the details of the data plotted above as well as the relative deviations of the calculated exposure values from the reference exposures. The average and standard deviation of these deviations are also given for each batch. The system will prompt you to choose a directory and a file name for the XLS file. You should type the file name with the extension (xls).
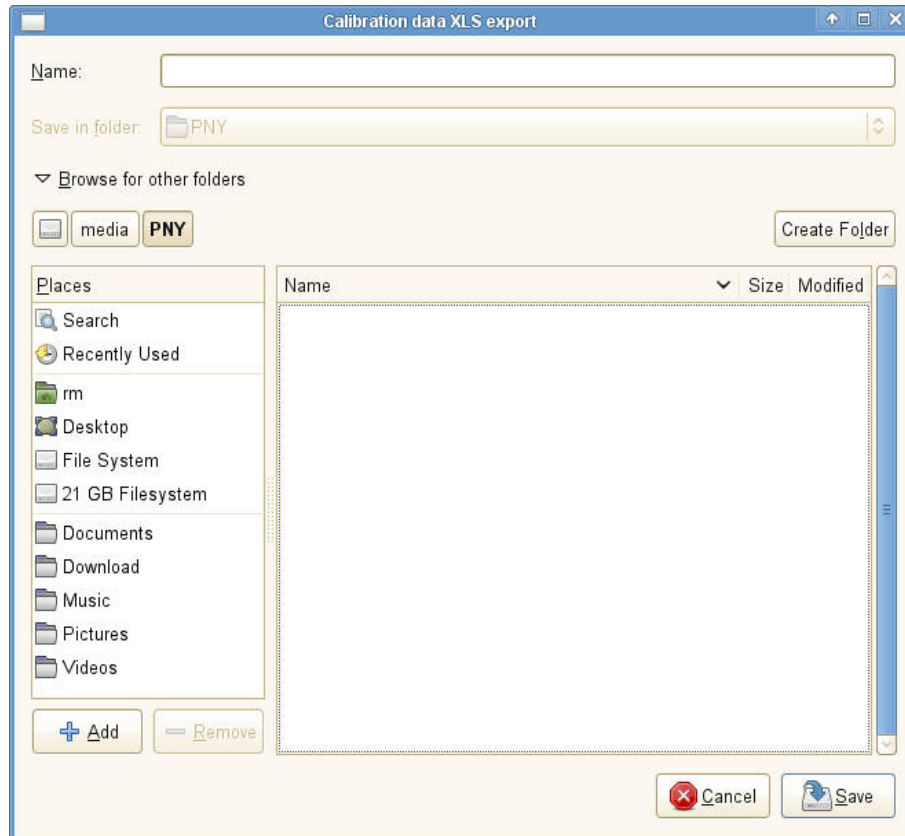
Saving the exported XLS file

18. The fitted parameters will be copied to the "Calibration" window. You can still modify the "Det ID From", "Det ID To" and "Comment" fields. Click the $\boxed{\text{Add}}$ button if the calibration is new or the $\boxed{\text{Save}}$ button to update an existing calibration.

19. With the calibration completed, the DMU main window will contain the correct values in the "Corr.Dens." (background corrected density) and "Rn Expos." columns.

5.5.5.1 Explanation and formulas for the calculated fields

Corrected Density: $C = D - BG$, where *D* is the measured track density, **BG** is the background density value.

Radon Exposure: $e^{\frac{\ln(C) + CF}{exp}}$, where *C* is the above corrected density, **CF** is the calibration factor and **EXP** is the exponent.

The **CF** should be in the range of 2.5 – 7. The **EXP** parameter is close to, but usually slightly smaller than 1 (0.85 – 1). The value of 1 means linear calibration.

5.5.6 CALIBRATION USING THE DMU-V6R SOFTWARE AFTER OCTOBER, 2012

Read this chapter at DMU sw versions installed after 15, October, 2012. For earlier sw versions read Chapter 5.5.5.

5.6 TIPS AND TRICKS

<Update text to be inserted here>

5.6.1 HOW TO IMPROVE THE IMPRECISION AT TRACK COUNTING?

The Evaluation Parameter Set (EPS) determines the details of the track image analysis and may influence on the results decisively. The EPS's are editable and are available to edit in the Measure/Automatic window. A few prototypes EPS are delivered with the installation set of the software. These prototypes are optimized for routine operation, where the basic requirement is a fast track analysis, about 1 min. per detector chip, but with a moderate repeatability of 7%.

At some applications, for example when an analysis is conducted for metrology intercomparison purpose, a better imprecision might be needed. The imprecision related to the track recognition operation of the software can be enhanced by the usage of an alternative EPS, which provides around 2% imprecision at repeated track analysis. The price of the bigger precision is the longer time of the analysis, with 5 minutes. Therefore the application of this mode is proper to refer as "Slow Mode". These specific EPS can be derived from any of the prototypes easily. The procedure for the creation of the corresponding EPS is described here.

Open the Automatic window in the Measure pull-down menu.
At the line "Parameter Set" select your EPS prototype, for example "2K Small Tracks"
Select the Edit button. A window with a series of editable parameter settings options is displayed.
Locate the "Focusing" line and change its value to "All".
Locate the "If No Plane" line and change its value to "Focus All".
And now save your new EPS. At the line of the name of the EPS, change the name of the prototype to any other one is desired. For example to "2K Small Focus All".
Click on the "OK" button. The window is closed and now the new EPS is available to use.
Use the new EPS by selecting it at the line of the "Parameter Set", when an analysis is started in Automatic/Measure. The new EPS, like any of the registered EPS, is also available at the "Manual" operation mode.

5.6.2 CHEMISTRY RELATED INFO

Merck NaOH + distillated water {Relevant text to be inserted here}

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Second use of chemicals. {Relevant text to be inserted here}

5.6.3 TRACK SIZE OPTIMIZATION

TA-software + Sample images for optimal track sizes.
{Relevant text to be inserted here}

5.6.4 SYSTEM CALIBRATION

{Relevant text to be inserted here}

5.6.5 SETTING UP NETWORK CONNECTION (RSV6X VERSION)

Two options are available to set up network connection with the standard Radosys notebook type computer. HP-nx6110.
Ethernet (cabled) network and/or wirless network (if you have a wireless access point in the building).

5.6.5.1.1 Ethernet Network

Ethernet (cabled) network and wirless network (if you have a wireless access point in the building).

For the Ethernet network, there is nothing to do, just connect the cable to the laptop computer. If you have a DHCP server at your company, it will get a network IP address automatically.
If you have to set up IP addresses manually on the windows computers, you have to do it manually also under linux:
Go to "K menu" -> System -> Control Center (YaST).
Type the administrator password (RMet2000).
Click on "Network devices" on the left and "Network Card" on the right.
Select "Hwelett-Packard Company nx6110" and click "Edit".
Set up IP address, Netmask, DNS server, Gateway address as your local network administrator provides them.

5.6.5.1.2 Wireless Network

To set up the wireless network, you need to do the following:
Go to "K menu" -> System -> Control Center (YaST).
Type the administrator password (RMet2000).
Click on "Network devices" on the left and "Network Card" on the right.
Select "Ethernet network card" and click "Edit".
Set up IP address if required by your network administrator, or leave it on automatic.
Click "Next" and set up the parameters of your wireless network.
If the settings are successful, the blue wireless light on the computer should light up.

5.6.6 WHEN ID CODE READING FAILS

There are occasions when the ID code reading may fail, which cases can not be handled by the software.
- When there is a scratch on the area of dote codes on the surface of the chip.
- In the high track density region, above 100 tracks/mm2. At this case the dot code structure is covered by tracks too dense and the software can not identify the code dots.

At any case, when the ID code reading fails, the code can be corrected in the software manually. This can be done either within the Radometer software or within the DMU. At this case read the alphanumeric ID code from the chip itself. The position number of the chip in the slide may help to identify the chip itself. The position numbering concept is described in Chapter 7.1.

- ID code correction within the Radometer track reader software:
In the Measure pull-down menu select Review Slide.
In the Slide Edit window select the last slide in the Slide ID line.
Edit the desired chip position by clicking on the corresponding field.
Click on the OK button to store the changes.

- ID code correction within the DMU-V6R database software:
In the main window, among the list of detectors, select the desired line by means of the known slide ID or Date&Time of the measurement, together with the Position information. If the Position column is not displayed, add this column to the chart configuration after clicking on the Configuration button.
After selecting the desired detector line, click on the button "Edit Detector ID" and edit the ID field. Click on OK button to save the changes.

Note: The Radometer software can be configured that the Slide Edit window be displayed after the measurement of a slide automatically. This setting can be achieved by modifying the actual EPS appropriately. For information about EPS settings refer to the chapter "EPS Settings".

5.7   RADOSYS SPECIAL TYPE DETECTORS

In the Radosys detector production program the RSKS type detector is the standard type. A few special types are also available for specialty applications. In this chapter type specific information for their operation and usage is given.

5.7.1   THE RADUET DETECTOR

The Raduet detector is an extension of the former standard type, the RSF type radon detector.

This detector type is dedicated to combination detection of radon and thoron activity at the same time.

It consists of two detectors – a standard RSF type detector and a modified version, the latter with reduced response time. The main chamber is selective for the radon activity primarily. But the secondary chamber is sensitive for both radon and thoron. By a simple linear calculation the radon and thoron activity data results can be separated and extracted.

The operation principle and metrology specification of the Raduet detector is reported in the following paper:

"Up-to-date radon-thoron discriminative detector for a large scale survey" by Shinji Tokonami, Hiroyuki Takahashi, Yosuke Kobayashi, Weihai Zhuo and Erik Hulber in Review of Scientific Instruments, Vol. 76: 3505-3509, 2005.

The cross sectional view of the Raduet detector is shown on the picture in the Chapter 2.5. On the picture the detector in the left is a standard radon detector called Rn-channel of the Raduet detector. The detector in the right is the modified type, which is equipped with enhanced sensitivity for thoron. This is called Tn-channel of the Raduet detector. This can be identified easy by the six holes on the round of its body. These big size holes provide enhanced ventilation rate, and consequently much shorter response time, for thoron detection. Since the lifetime of the thoron is much shorter than of the radon, the larger ventilation rate allows the thoron gas diffusing into the diffusion chamber before it decays. Contrary, at the standard RSF radon detector the standard air gap acts as a barrier for the thoron gas, while the air gap is much more transparent for the radon gas. Consequently, the Rn-channel is almost non sensitive for thoron at all, while the Tn-channel performs high sensitivity for thoron, too. Both channels are sensitive for radon, with almost the same level of sensitivity.

In other words, the CR-39 chip inside the Rn-channel registers only those tracks, which come from radon decays. And the Tn-channel registers all the tracks coming from both radon and thoron decays. This means that the counted track density in the Tn-channel is the sum of the tracks originated from both radon and thoron decays. Proper calibration data and combination calculation is able to extract the individual radon and thoron activity data from these two track density values.

The Raduet detector consists of the radon and thoron sensitive diffusion chambers and a plastic tray, which joints them together. These three components together form a unit. When the Raduet detector deployed, the whole unit should be kept together in its original form, during the time of exposure. Like at all types of Radosys detectors the unit

is delivered sealed into radon-proof foil bag. Removing the sealing the exposure period starts instantly. For general information about the usage please find information in the corresponding Chapter 4.1 describing the deployment of Radosys detectors generally.

Processing the exposed Raduet detector.

Dismantle and etching of the detector is done the same way like the standard Radosys detectors, see Chapter 4.2. The difference is that the Raduet consists of two CR-39 chips. Like at all Radosys detector types the diffusion chambers are labeled, where the ID code on the label is identical to the ID code engraved onto the surface of the CR-39 chips. The ID codes on the two CR-39 chips are adjacent. The ID code of the Rn-channel is always an odd number and the Tn-channel is labeled with the next even number.

The track counting on the etched chips is done by the track reader software the normal way. But now two track density values are provided - one for the Rn-channel and a second one for the Tn-channel. These values are listed in the DMU software, but the calculation of the activity concentrations is not implemented in the current version of the DMU software. This calculation have to be done separately, for instance by means of a spreadsheet software like the MS Excel. Consequently, the data list provided by the DMU software has to be exported for this purpose. For information how to export data list to Excel, see Chapter 5.5.4.

The channel specific exposure values in kBqh/m3 are calculated from the channel specific track density values by the following calculation, which actually is a matrix multiplication. (See also the Note 5.7.1 below)

RnExp=CF*(1.00*RnD-0.02*TnD)
TnExp=CF*(-1.11*RnD+ 1.21*TnD)

The activity concentration value is calculated from the exposure value and the time of exposure as usually:

RAC=RnExp*1000/24/T
TAC=TnExp*1000/24/T

The following abbreviations are applied in these formulas:
RnExp: Exposure value for the Rn-Channel, in kBqh/m3
TnExp: Exposure value for the Tn-Channel, in kBqh/m3
RnD: Track density counted for the Rn-channel, in mm-2
TnD: Track density counted for the Tn-channel, in mm-2
CF: Batch Depending Calibration Factor provided by the Radosys QC system.
T: Time of exposure in Days
RAC: Radon Activity Concentration, in Bq/m3
TAC: Thoron Activity Concentration, in Bq/m3

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Result of track analysis for Raduet detectors
Date: .08/02/2008
Radosys Ltd
Date of Revision:

det_id	slide_id	date	Track Density tracks/mm2		density	Exposure kBqh/m3	Time of Exposure Days	Activity Concentration Bq/m3	
F38151	2005-04-21	2005-04-21	1.79487	Rn-Channel	1.79487	81.71904	79	43	Rn
F38152	2005-04-21	2005-04-21	3.50427	Tn-Channel	3.50427	106.502	79	56	Tn
F38155	2005-04-21	2005-04-21	2.79914	Rn-Channel	2.79914	126.7089	87.5	60	Rn
F38156	2005-04-21	2005-04-21	6.23932	Tn-Channel	6.23932	210.4839	87.5	100	Tn
F38157	2005-04-21	2005-04-21	2.52137	Rn-Channel	2.52137	115.6339	88	55	Rn
F38158	2005-04-21	2005-04-21	4.03846	Tn-Channel	4.03846	98.9192	88	47	Tn
F38161	2005-04-21	2005-04-21	4.95726	Rn-Channel	4.95726	228.8174	88	108	Rn
F38162	2005-04-21	2005-04-21	6.38889	Tn-Channel	6.38889	105.5609	88	50	Tn
F38163	2005-04-21	2005-04-21	2.73504	Rn-Channel	2.73504	126.2029	85.5	62	Rn
F38164	2005-04-21	2005-04-21	3.56838	Tn-Channel	3.56838	60.73291	85.5	30	Tn

Conversion Matrix

Calibration factor for Radon: CF=   47.38   (RSF-Chamber)   1   -0.02
Multiply Track Density [tr/mm2] by CF to get Exposure Value [kBqh/m3]   -1.11   1.21

Sample of calculation chart for Raduet detector.

Note 5.7.1.
The coefficients for the calculation of radon and thoron activity concentrations are reported on the basis of the following paper.

"Up-to-date radon-thoron discriminative detector for a large scale survey" by Shinji Tokonami, Hiroyuki Takahashi, Yosuke Kobayashi, Weihai Zhuo and Erik Hulber in Review of Scientific Instruments, Vol. 76: 3505-3509, 2005.

For individual calibration requests for Raduet detectors please contact NIRS at the address and email address referred in this paper.

5.7.2 RADUET IMPRECISION

1. The calibration factor (*CF*) performs some variation from batch to batch. The manufacturer Radosys supplies calibration factor data information on radon regularly. For example

Detector batch	$CF\left(\dfrac{\text{kBqh}/\text{m}^3}{\text{track}/\text{mm}^2}\right)$	Relative uncertainty
R98560 - T24624	43.63	4%
T35425 - T63684	36.58	4%

The matrix used for the exposure calculations is

$$\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} = \begin{pmatrix} 1.112 & -0.119 \\ -2.434 & 2.576 \end{pmatrix}$$

and the uncertainties of the matrix elements are

$$\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} = \begin{pmatrix} 0.107 & 0.028 \\ 0.204 & 0.216 \end{pmatrix}.$$

If c_{Rn} and c_{Tn} denote the net track densities in the low and high air exchange rate chambers, respectively, then the exposure to radon and thoron is calculated by the following formulas:

$$E_{Rn} = CF \cdot (a_{11} \cdot c_{Rn} + a_{12} \cdot c_{Tn}),$$

$$E_{Tn} = CF \cdot (a_{21} \cdot c_{Rn} + a_{22} \cdot c_{Tn}).$$

Thus, the uncertainties in the exposures can be calculated as follows:

$$D^2(E_{Rn}) = (a_{11} \cdot c_{Rn} + a_{12} \cdot c_{Tn})^2 \cdot D^2(CF) + CF^2 \cdot ((a_{11})^2 \cdot D^2(c_{Rn}) +$$
$$+ (c_{Rn})^2 \cdot D^2(a_{11}) + (a_{12})^2 \cdot D^2(c_{Tn}) + (c_{Tn})^2 \cdot D^2(a_{12})),$$

$$D^2(E_{Tn}) = (a_{21} \cdot c_{Rn} + a_{22} \cdot c_{Tn})^2 \cdot D^2(CF) + CF^2 \cdot ((a_{21})^2 \cdot D^2(c_{Rn}) +$$
$$+ (c_{Rn})^2 \cdot D^2(a_{21}) + (a_{22})^2 \cdot D^2(c_{Tn}) + (c_{Tn})^2 \cdot D^2(a_{22}))$$

The $D(c_{Rn})$ and $D(c_{Tn})$ uncertainties can be calculated by exposing several detectors (preferably a few tens of detectors) to the same exposure and then counting their track densities several times (preferably 5-6 times). The standard deviation of these track densities will, of course, depend on the exposure, so this calculation should be repeated at different levels of exposure.

2. Example calculation

Let's suppose that the two Raduet detectors belong to the detector batch that has a calibration factor of 43.63 $kBqh/m^3/(track/mm^2)$ and the track density on the detector in the low air exchange rate chamber is 10 $track/mm^2$ and that in the high air exchange rate chamber is 14 $track/mm^2$. The usual uncertainties at these levels of track density are about 0.7 $track/mm^2$ and 0.8 $track/mm^2$, respectively. Thus
- the radon exposure is 413 $kBqh/m^3$,
- the thoron exposure is 511 $kBqh/m^3$
and the uncertainty
- for the radon exposure is 63 $kBqh/m^3$ (15%),
- for the thoron exposure is 200 $kBqh/m^3$ (39%).

6   System Metrology Performance Information

{Relevant text to be inserted here}

6.1 LINEARITY

Radosys Ltd   File issued at: 11 October, 2004.

Data about the linearity performance of the Radosys Track Counter Algorithm

Algorithm version - RM-series software

Exposure was carried out in a secondary standard calibration chamber, Czech Republic

Raw data is plotted on the figures

The reason of the outlier at 1000 kBqh/m3 is unknown, but probably the meter reading failed

Linearity test on the Radosys Track Counter Algorithm

Linearity test on the Radosys Track Counter Algorithm
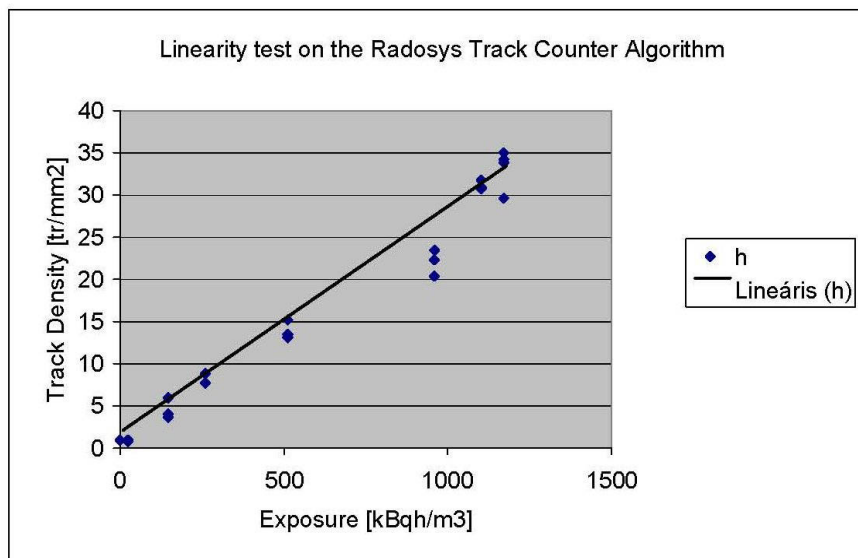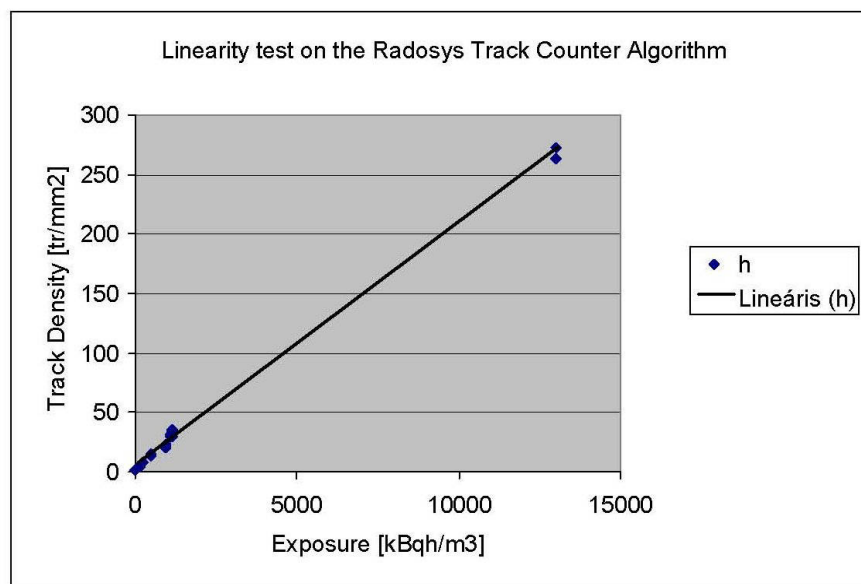
6.2   RADOSYS CR-39 QUALITY CONTROL STATISTICS DATA

Quality Control Statistics for Background Value
at Radosys made Cr-39 chips
Typical production batch
Size of batch: 8000 detectors
Number of QC detectors: 500
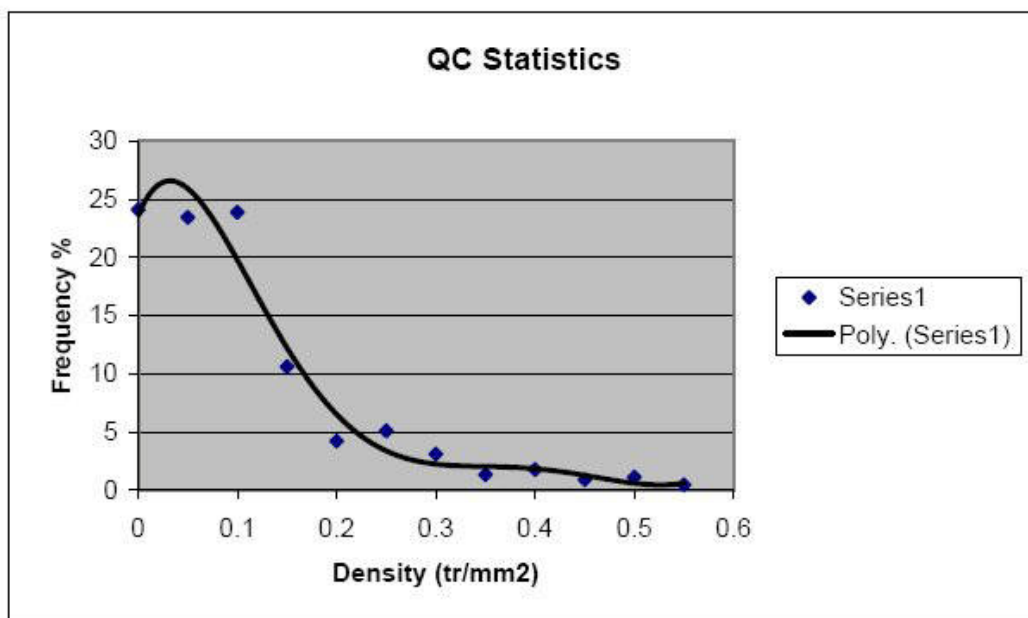
QC Statistics

6.3 ACCURACY AND IMPRECISION

Intercomparison acheivable theoratical limit for SD%

kBqh/m3	Density	Tracks#	Best SD%
117	2.925	146	8.3
294	7.35	368	5.2
2290	57.25	2863	1.9
Mean of SD% =			5.1

Theoretical absolute limit is rigorous by Poisson statistics
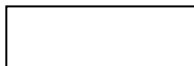
6.4   THE QUALITY CONTROL SYSTEM OF THE RADOSYS MADE RADON DETECTOR PRODUCTS

6.4.1 INTRODUCTION

Any commercial product needs a well-established quality control.
Our radon detector products are also manufactured according to a well-defined quality control procedure.

Our company always, since the birth of the Radosys product line, paid particular attention to the quality of the products. Especially on the area of the manufactured radon detectors, we were always focusing our efforts on to provide the best quality detectors for our dear customers. A well-defined quality control has been applied at the manufacturing our detector products since the beginning.

Today our radon detectors are manufactured with big quantity and continuously. This condition of regular manufacturing makes us possible to fix our quality control procedure in long term sense. This also means that now we are in the position that we can publish the details about our quality control system.

The purpose of this document is to share this information with our dear customers in order to enhance our technical support for our products.

By publishing this document, also information about the existing quality control procedure is provided, as well as further plans of the near future is included.

6.4.2 QUALITY CONTROL OF THE MANUFACTURED CR-39 DETECTOR CHIPS

The Quality Control is conducted in two main steps.

6.4.2.1.1 Quality inspection on the dimension and surface quality of the manufactured chips.

Each sheet of detector chips is inspected according to the next rule.
Surface quality: Any chip having scratch or damage on its surface is removed and rejected. This aspect is considered in order to ensure the best operation and accuracy of the track analysis software.
Chip dimension: The width of the chips is inspected. The criteria of acceptance is a width from 0.95 mm to 1.10 mm. Any sheet which does not meet this criteria is discarded and rejected. This sorting procedure ensures the matching condition to size of the holder frame, which is applied during the etching/analysis process.

6.4.2.1.2 Quality control on the application related physical characteristics of the manufactured chips.

The CR-39 chips that provide the quality inspection data are selected by a systematic way to be a true representative of the production series.
The next system is applied.

Today the single size of the Radosys production CR-39 sheet is 45 chips. Five CR-39 chips of 45 are removed for quality inspection purpose by means of a definite selection map. The selection map is fixed providing a homogenous sample distribution along the entire area of the production sheet. This is not a random selection, but a systematic way,

Chapter 6. _____ **System Metrology Performance Information**

in order to eliminate any arbitrary decision by the production workmanship. But this selection system may provide a homogenous sampling of the production sheets.

These five removed Q.C. chips are used for the next purpose.

- Three of them are developed and evaluated for the determination of the background value. This means around 7% sampling rate. Any sheet providing a background value exceeds 0.5 tracks per mm2 at any control chip of the three, that sheet is discarded and rejected.

- A part of them is exposed for sensitivity calibration by systematic 0.7% sampling rate. Standard RSFS type detectors are manufactured by means of these control chips. The detectors are exposed in a radon calibration chamber with governmental accreditation. After return these detectors are etched and analyzed in our lab. This provides a CF [Calibration Factor], which value is characteristic for the whole batch of detector chips. The typical size of a production batch is 20000.

- The remainder of the control chips is preserved for archiving, for any future countercheck purpose.

6.4.2.1.3   Description about the QCS information files

In order to enhance our technical support service at our radon test products, the QCS [Quality Control Sheet] system has been introduced.

This means that quality test data for each delivered Radosys radon test product series is supplied. This data is provided in printed media format or in suitable electronic format, floppy disk, CD, or data file by email. (See Note 1.)

The next information is included in the Quality Control Sheet, QCS:

--- Statistics about the background test. Average value and SD%, also the applied quantity of the Q.C. sample expressed in percentage.

--- Information about the lot of the CR-39 plastic molding. Month of date of the molding, with indication about the ID code range of detectors belonging to the same plastic molding event. This range of detector chips comprises a production batch.

--- Sensitivity data and Calibration factor and statistics about, which data is characteristic for the whole production batch. Average value and SD%, also the size of the Q.C. sample expressed in percentage.

--- The QCS file are provided in two steps, as follows.

--- Step 1. The delivery-time-version includes the data about the background test. Also a typical average value of the Calibration Factor is included.

--- Step 2. The completed version is issued within three month from the date of delivery of the detector package. An exact calibration factor is included in the final version of the QCS.

Note 1. From November, 2006 we introduce a full automatism for calibration data settings. This means that the calibration chart will be available at our web site in file format, which file will be processed by the Radosys system as a software upgrade, or on-line for Radosys computers with internet access.

Chapter 6. _____ **System Metrology Performance Information**

6.4.2.1.4 Sample of QCS [Quality Control Sheet] file

Quality Control Sheet

for Radosys brand radon detector products

QCS File Reference	QCS_C32_051213
Shipment Code	E8505
Customer Code	CC32/CC10
Date of Shipment	13/12/2005
QCS Issue Date	21/12/2005
QCS Revision Information	Preliminary QCS – Standard CF Reported
QCS Revision Date	
Revised by	EH

ID Code Range			
	From	G86430	
	To	G87554	
Batch Info			
	BID	S051017	
BG Test			
	Mean	0.10	TR / mm^2
	SD	0.08	TR / mm^2
	QSR	2	%
SEN Test			
	Mean	0.02249	TR m^3 / kBq h mm^2
	SD	0.00125	TR m^3 / kBq h mm^2
	QSR	0.1	%
Conversion Factors			
	CF-RSF	44.47	
	DMU Factor RSF	1853	
	CF-RSE	37.04	
	DMU Factor RSE	1544	

Explanation on the applied terminology

BID – Batch ID Of Plastic Mold Event at Manufacturing the CR-39 material

Mean - Mean value of Quality Control chips, that were included in the test

SD - Standard Deviation of Quality Control chips, that were included in the test

QSR - Sampling Rate of Quality Control Chips, that applied at the test

BG - BackGround. Initial track density at the time of manufacturing

TR - Number of Tracks

SEN - Sensitivity - Test condition: Exposure was carried out with RSF type diffusion chamber

CFRSF –Multiply Track Density [tr/mm2] by CFRSF to get Exposure [kBqh/m3] at RSF chamber

DMU Factor RSF– Enter this value in the DMU to get calibrated RAC data at RSF chamber

CFRSE –Multiply Track Density [tr/mm2] by CFRSE to get Exposure [kBqh/m3] at RSE chamber

DMU Factor RSE– Enter this value in the DMU to get calibrated RAC data at RSE chamber

7   Radosys System Engineering Details

7.1   RADOSYS **CR-39** CHIP STRUCTURE

The coordinate system of the chip scanning operation. This information is useful at Manual Control Mode or at general track research applications.

Components of the Radosys detector CR-39 chip.
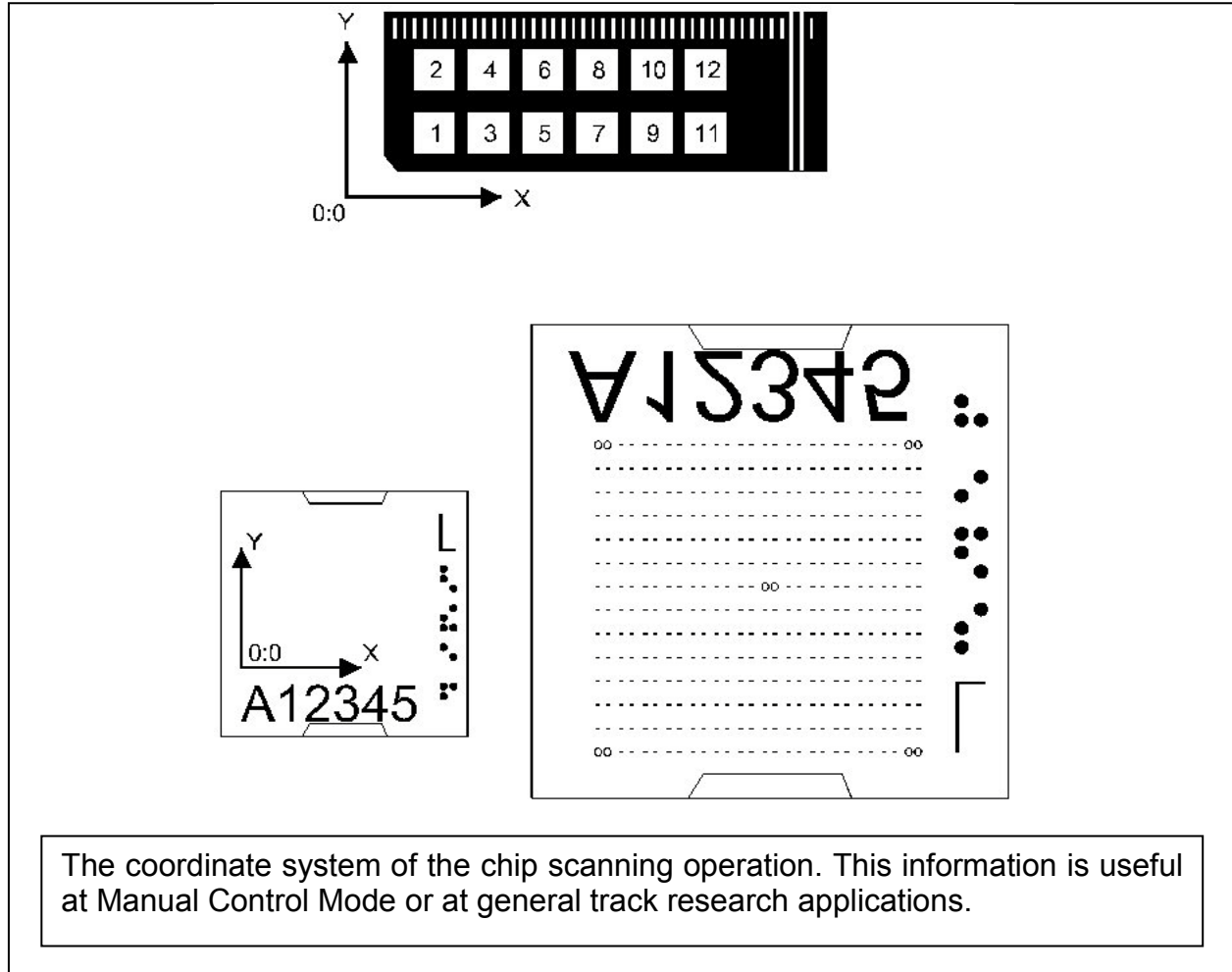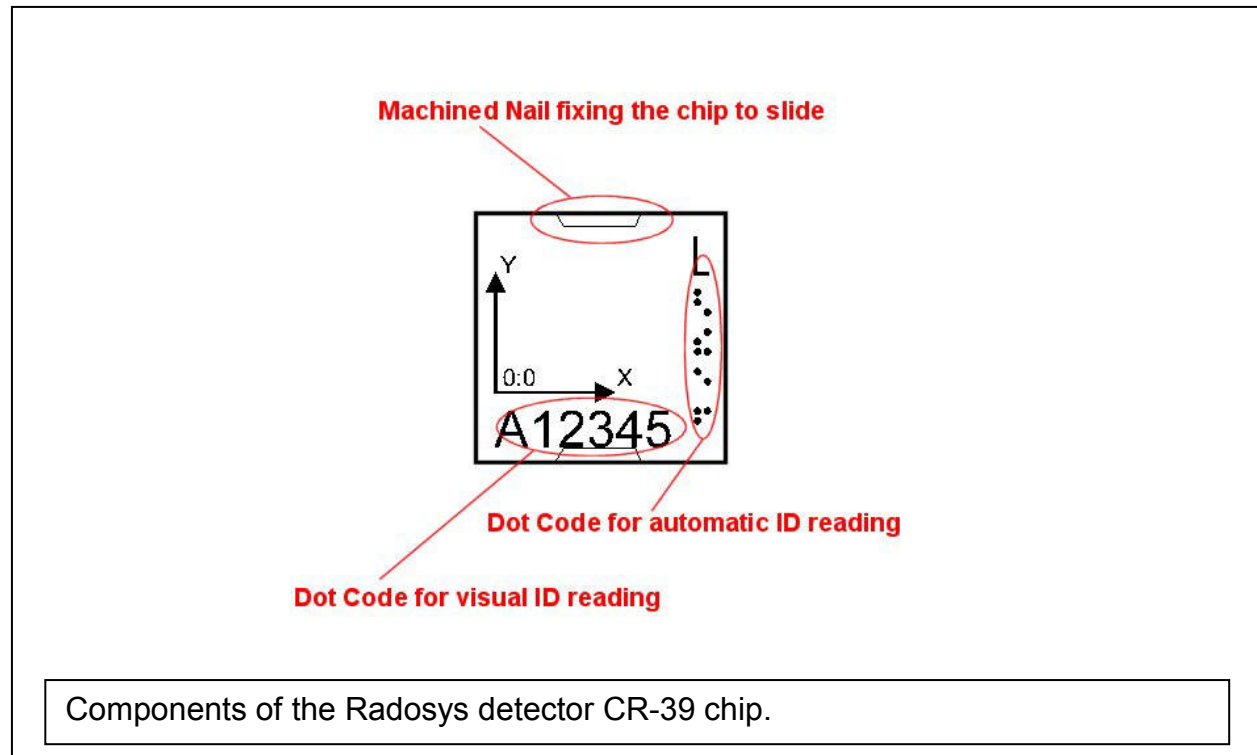
7.2 RADOSYS RADON DETECTORS

Selected explanatory texts for the physics and engineering operation of the Radosys detectors, as well as for their characteristics are collected together in this chapter.

7.2.1 GENERAL OVERVIEW ON RADOSYS RADON DETECTOR'S PRINCIPLE OF OPERATION

All types of Radosys radon detectors consist of the following components:

- Diffusion Chamber
- PADC/CR-39 chip
- Radon-proof foil pouch
- ID labels and logo labels

At certain models additional components may exist, which are specific for the given application.

Regardless of the actual type of the detector, the core components are the diffusion chamber and the PADC/CR-39 chip. From point of view for the principle of operation, these components, and their performance, are the most decisive for the operation of the detector. All the other components can be considered just added extras, providing useful features for a test service operation or for a specific application area.
However, of course, at certain special Radosys detector are based on extra, non-conventional scientific approaches, which are dedicated for specific area of applications.

But for all that specific types the fundamental core elements are the diffusion chamber and the PADC chip, as well.

In this chapter the basic principle of operation is demonstrated by means of the RSKS type radon detector. This explanation is focused on the principle of operation mainly from scientific points of views.

The Radosys RSKS radon detector follows a conventional principle of operation, which principle has been already described in many scientific papers since mid 80's, and even practical devices on the field have been utilized for ten/fifteen years. Therefore the principle of operation is far not new and the strength of the Radosys detectors is not the principle itself, but the enhancements achieved by means of their distinguishing structure, production technology, quality control, metrology performance and related services.

The radon detector consists of a diffusion chamber and a PADC chip inside.
The PADC chip is a specific plastic piece, which is sensitive for alpha particles; the latter comes from decaying of the radon gas. The role of the diffusion chamber is that only those radon decays contribute to the measurement result, that occur inside the chamber. This principle makes the whole structure applicable for definite, traceable and reproducible measurements from metrology point of views.

The inner structure and components of the RSKS type radon detector
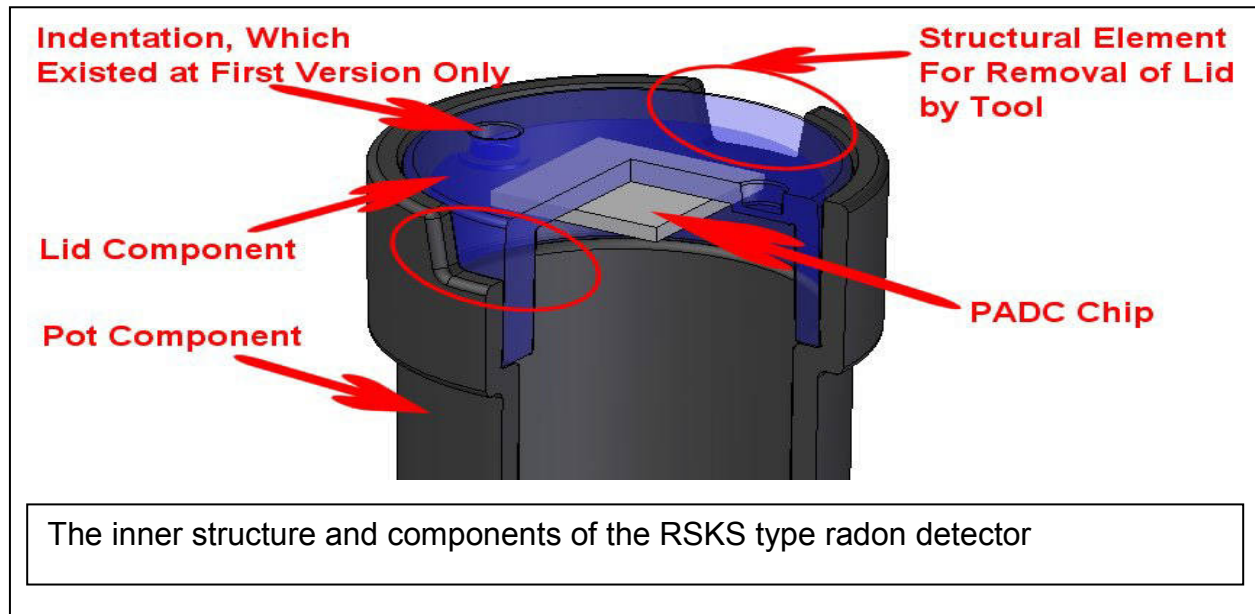
7.2.2 ABOUT THE AIR-GAP OF THE DIFFUSION CHAMBER. PRINCIPLE OF OPERATION.

The diffusion chamber consists of pot and lid sections. These are matching plastics parts. However like at all kind of matching plastics parts, this matching is not perfect and there is a very narrow gap between the pot and lid. The size of this mismatch is in the range of ten micrometers. The radon gas diffuses inside through this gap, while its path

in the gap is much longer than the width of the gap, which is an important character of this air-gap principle.

The radon is noble gas, it is completely neutral, and it does not take part in any chemical reaction or surface-physics interaction. Its movement is driven by pure diffusion process. The size of the radon atom is in the range of 10^{-4} micrometer. When this size is compared to the size of the air-gap, the 10 micrometer, it is understandable that the radon gas is able to diffuse into the diffusion chamber effectively.

The radon gas is radioactive element and its radioactive decay results in daughter elements, which are also radioactive. Some of them also produces alpha particle, which is able to create tracks on the sensor, the PADC chip. The character of the daughter elements is quite different than of the radon atom. These are chemically reactive elements and take part in many chemical and surface-physics interactions. As they are born they are deposited to aerosol or dust particles in the air, so the aerosols carry the daughter elements afterwards. The aerosol particles tend to be deposited to solid surfaces, like the wall of the diffusion chamber.

The typical size of the aerosols is in the range of 0.1 micrometers. When the aerosol enters the air-gap of the diffusion chamber, it migrates through a long but narrow channel. During its route it gets deposited to the wall with high probability. Consequently the air-gap acts as a barrier for aerosol particles and for the radon daughter elements as well.

All these means that the air-gap of the diffusion chamber filters out the external decay components of the radon gas, while the gap is transparent for the radon gas. Only those alpha particles are registered by the PADC sensor, which are born inside the diffusion chamber. So the point is that the radon detector works with a definite time stamp. Only those radon decays contribute to the tracks created on the sensor, which occurred after placing the detector to the site to be tested.

The diffusion path of radon into RSKS type radon detector
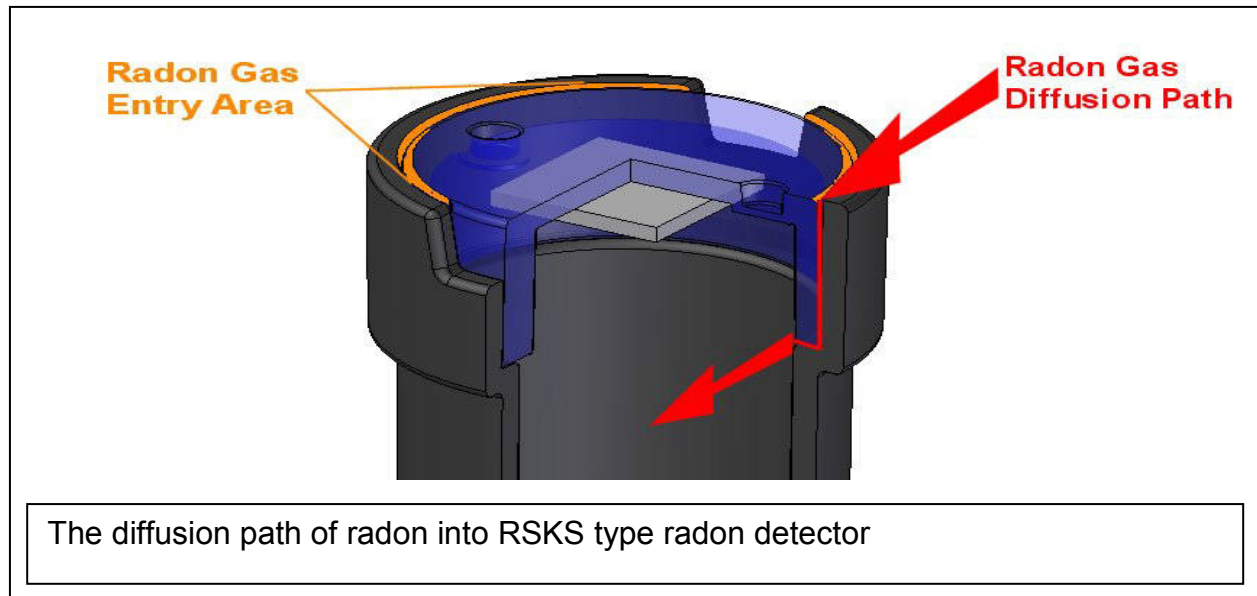
7.2.3 ABOUT THE MATERIAL OF THE DIFFUSION CHAMBER.

The diffusion chamber is made of conductive plastics. This enhances the homogeneity of the track density on the detector chip.

The geometry of the diffusion chamber is cylindrical. The detector chip takes place on the axe of this cylinder and its surface is perpendicular to this axe. The entry point of the radon, the air-gap is also symmetrical to this axe. Consequently, the whole structure shows cylindrical symmetry. This ensures that the track density on the detector surface is homogeneous. Without homogeneous track distribution the imprecision of the track counting would be very wrong. Therefore any effect, which is able to reduce the desired homogeneity, has to be avoided.

Electric surface charge on the wall of the diffusion chamber is one sort of these unwanted effects.
- When the radon gas decays in the diffusion chamber, the resulted alpha particles are charged particles and normally the travel trajectory distribution is symmetrical. At presence of any surface charge on the wall causes distortion in this symmetry.
- Decay of the radon gas produces also daughter elements, which are radioactive, too; and some of them are alpha particle emitters, too. The daughter elements, with assistance of aerosols in the air, are depositing to the inner wall of the diffusion chamber. This is the so called "plate-out" effect. Emitting alpha particles they contribute to the track density on the detector chip. Consequently, it is desired that their distribution on the wall be homogeneous as well. At presence of any surface charge on the wall causes distortion in this symmetry.

Formation of electric surface charge on the inner wall of the diffusion chamber may occur if the material of the chamber is insulator. With some rare exceptions the technical

plastics are perfect insulators. But a few, special composite plastics types contain conductive additives, which formulation gives electrically conductive character.

The Radosys diffusion chambers are made of conductive composite plastics. This material selection eliminates the risk of formation of surface charges on the inner wall of the chamber. The lack of potential surface charge formation on the wall keeps the overall symmetry of the whole structure and of its physical operation.

The detector material, the PADC chip, is insulator. However if any electric charge is formed on its surface, at the time of assembling the detector, this charge is conducted away through the water contents in the air towards the conductive chamber rapidly.

7.2.4 ADDITIONAL INFORMATION

<Text for the engineering details chapter:>
RSKS type detectors:
Shelf life is 6 months. It lasts even much longer, however quality tests have been made for this length of time.
Background tests. Figure.
Sensitivity variation in time, which depends on the temperature during storage.
Repeated calibration is recommended after six months.

Text for the engineering details chapter:
Bar code
ID codes identical on the pouch, on the top section of the canister and on the PADC chip.

7.3   RADOSYS MICROSCOPE OPTICS OVERVIEW

The microscope operates on the principle of trans-illumination. Below the detector card the light source is an LED with a wavelength of approximately 465 nm. Illumination follows the Köhler principle, with the path of the beam as illustrated by the next figure. The object, that is the detector is in the focal plane of the illumination condenser.

Figure   Path of illumination beam
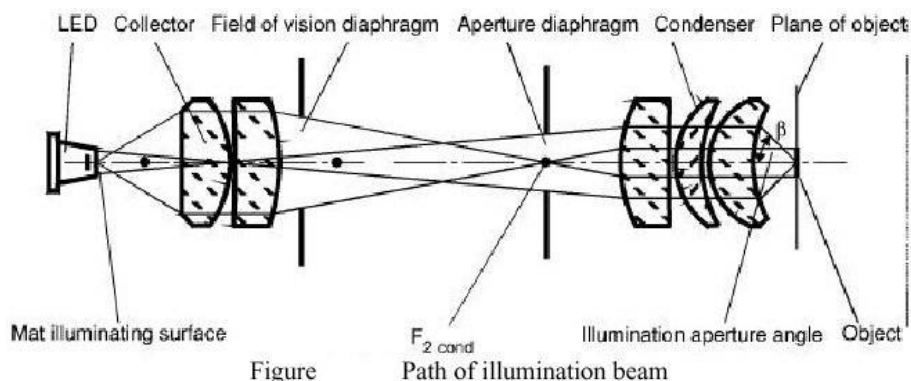
A Wetzlar Will microscope objective of 40x magnification is placed above the detector so that the object falls between the first and second focal planes. Its aperture angle (α) is not fully utilized by the aperture angle of the condenser (β), where $\beta<\alpha$, so that the appropriate contrast effect may be achieved.

Figure   Schematic diagram of optics
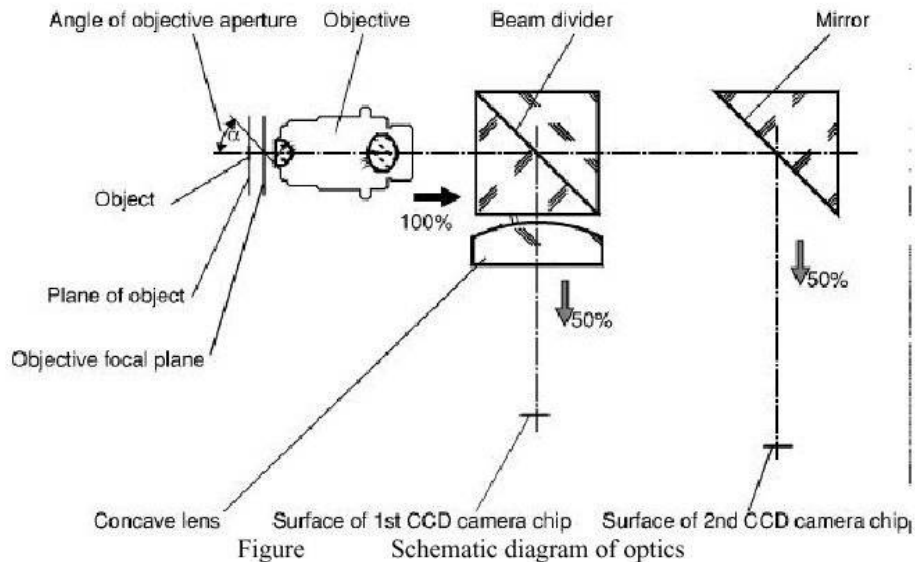
In order to the detector can be examined in images of two different magnifications, the light is divided using a beam splitting prism system. The image that proceeds straight through the beam splitter is reflected by a mirror into the upper camera. The size of the camera chip is 8.8 x 6.6 mm, and magnification is 40x, so the area viewed is 0.22 x 0.16 mm. In order to shorten the route of the light, a condenser is placed in the path of the light which leaves the beam splitter sideways, so that a magnification one-third of the original magnification is received. Therefore the total area viewed is 0.65 x 0.48 mm.

7.4   RADOSYS MICROSCOPE MECHANICS OVERVIEW

7.4.1 MECHANICAL ARCHITECTURE

The Microscope Unit consists of the following main units:
        the upper cover, which consists of a collar and a transparent plexiglass bulb;
        the base, which includes the motor board and the microscope
The microscope consists of two, structurally distinct parts: the lower part and the upper part. (Functionally, this distinction does not hold.) The upper part is held to the lower part by three screws, and loosening these screws allows the upper part to be tipped toward the right. Orientation pegs facilitate precise re-assembly.
The lower parts contains the illumination system, mechanisms for motion in the X and Y directions and the detector-card holding tray. Within the unit there are three levels built one on top of another.

The lowest level is the base plate, on which the illumination optics, the stepping motor moving the X table, the guide rails for the X table, and the gate covering the card insertion slot are all mounted.

The second level is the X table, with the following units mounted on it: the stepping motor moving the Y table, the roller opening the gate and the guide rails for the Y table.

The third level is the Y table. (The names of the tables are defined by the direction of their motion.) This level is where the card holding frame is located.

The frame of the upper part is a welded tripod. The shaft that enables motion in the Z direction is installed on the tripod, as well as the stepping motor that drives the shaft through a worm-gear transmission, the card insertion motor, the electromagnets that place the detector cards and the upper optical system of the optical unit.

The detectors to be analyzed are inserted into the Slide. The motion mechanisms are responsible for getting the individual detectors under the objective, designating the various examination points (motions in directions X and Y) and focusing the images (motion in direction Z).

Front view of the Microscope without the upper cover.(V200X and RSV6 versions)

Left view of the Microscope without the upper cover. (V200X and RSV6 versions)
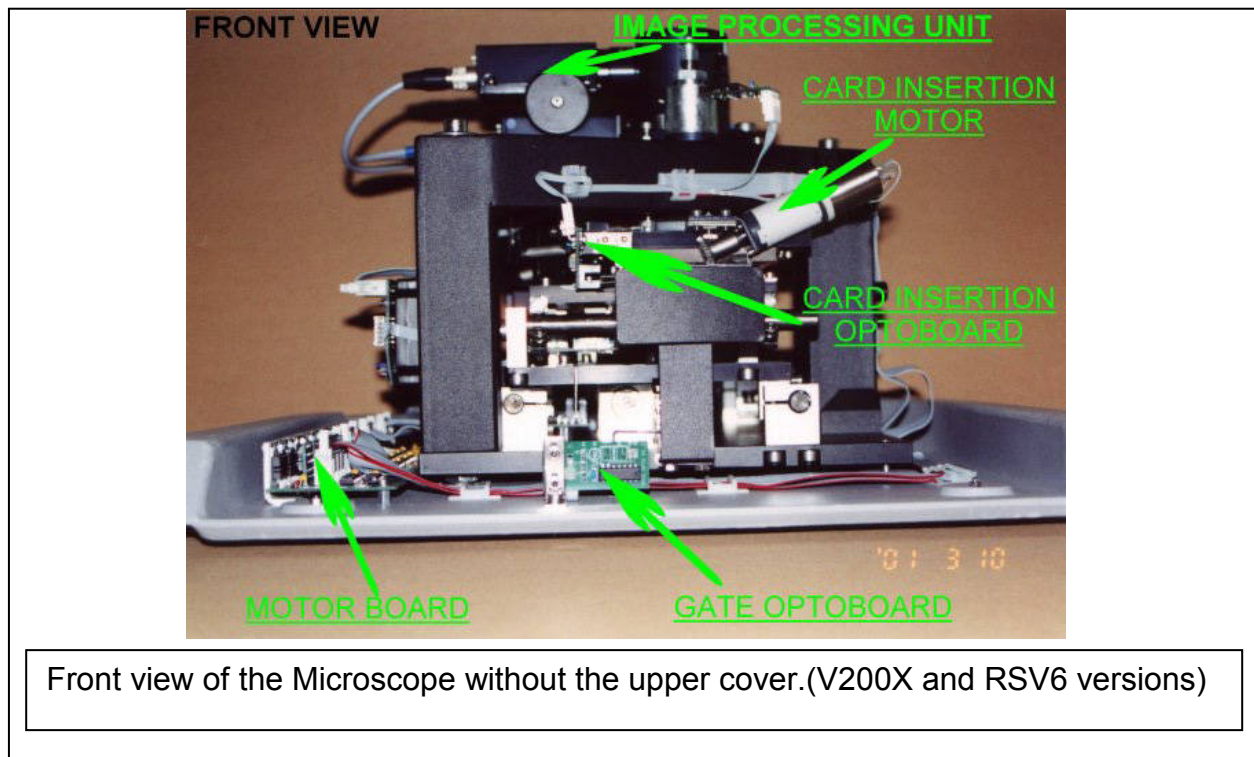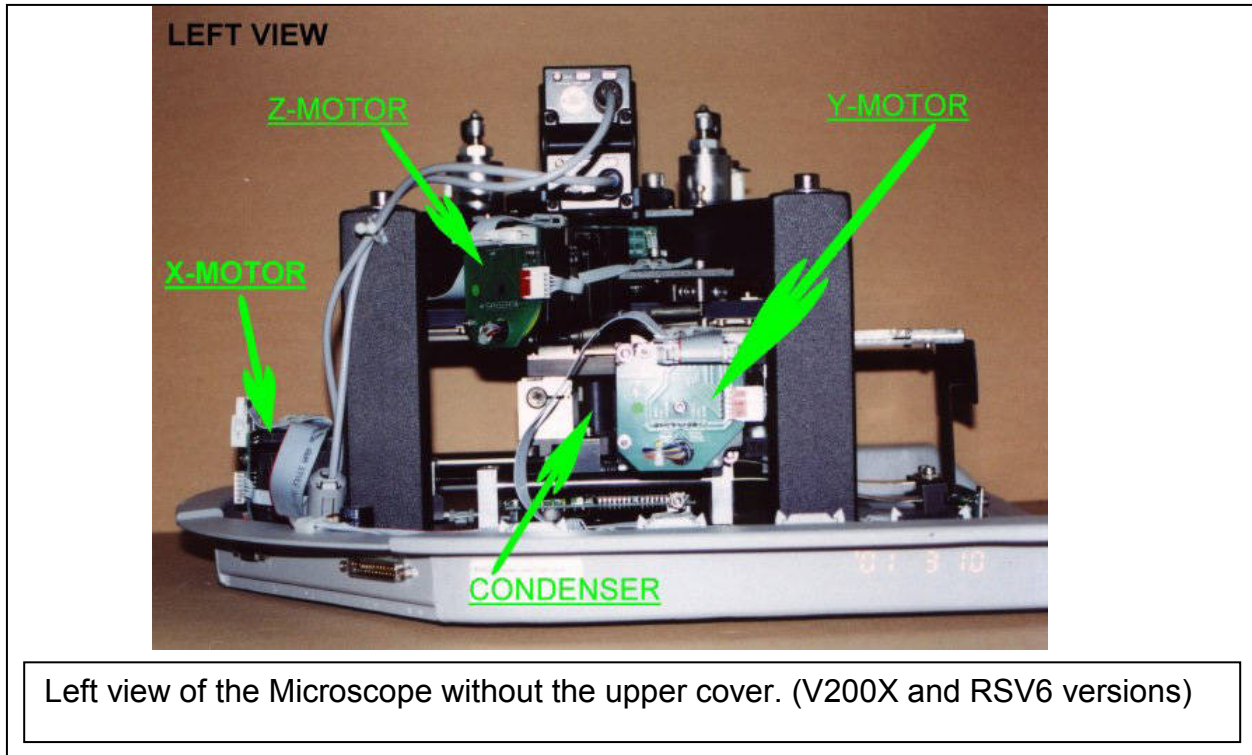
7.4.2 MOVEMENTS

7.4.2.1.1 Card Insertion

When the instrument is in insertion position, the card may be placed manually in the card holding tray. The signal coming from the optosensor that detects the presence of the card activates the card insertion motor, which rotates a cogwheel to engage teeth located along the edge of the card, taking the card and inserting it in the instrument.

7.4.2.1.2 Placement

The card insertion motor itself cannot fix the card to the tray. The rods of the electromagnets installed on the tripod are responsible for further placement within the card holder tray. While the tray moves, the rod of the activated electromagnet prevents the card from any unexpected displacement. Therefore the card is fixed to the tray firmly, and the card moves together with the tray exactly.

7.4.2.1.3 Positioning

During the operation, the card is moved within its optically relevant area. This is done by remote controlling the motion of the card holding tray along the X as well as the Y directions independently. Motion is executed by stepping motors, which make 500 steps/revolution. By means of a flexible gear coupling, the motor drives a lead screw bearing two intertwined threads with a slope of 2 mm. Thus the movement produced by each step of the motor is 4 μm.
The X and Y tables are driven by a rigidly fastened nut, welded to them by flexible deformation. The Y shaft has one bearing, while the longer X shaft has two bearings.

Chapter 7. _____ **Radosys System Engineering Details**

Each table rolls on a set of cylindrical guide rails. Each rail has two pairs of bearing casings with 3 bearings rolling on one side and, in order to avoid over-definition, 2 bearings rolling on the other side of each. One bearing in each casing is placed on an eccentric axis to allow adjustment for smooth, precise operation. Table motion is limited by opto-sensor tabs, which prevent the rollers from running up against the rail supports.

7.4.2.1.4 Focusing the Microscope Objective

Focusing is achieved by moving the card vertically, rather than the objective, in the following manner.

The objective of the microscope, together with the upper optical unit, is fixed. The detector-card holding tray is flexibly supported in the Z direction on a glass plate that can move in the Z direction. Motion is executed by a stepping motor with a precision of 500 steps/revolution, with a gear shaft fastened to its axle. The shaft-to-worm-gear ratio is 1:42.5. The lead screw revolving together with the worm-gear has a slope of 1 mm. Thus the movement produced by each step of the motor is 0.05 μm. The glass plate moves in the Z direction and, as a result of the flexible mounting, the card holding tray and consequently the detector move up and down along with it. Through this procedure the microscope can produce a focused picture anywhere within the range where the surface of the detector expected to be. Any extreme position are limited by optosensor tabs, and the entire range of the movement is approximately 0.7 mm.

7.5   RADOSYS MICROSCOPE CONTROL OVERVIEW (RADOSYS 200X VERSIONS)

7.5.1 CONTROL BOARDS

The entire operation of the Microscope is controlled by the Radosys Computer Unit. Therefore no any manual action is needed for the hardware operation of the Microscope, except the insertion and removal of the detector holder card.

However to be prepared for any unexpected specific event, some degree of manual interaction with the hardware of the Microscope is permitted and the related hw facility is available inside the Microscope. Such unexpected specific event may occur at any unlikely malfunction or at improper operation of the Microscope.

IMPORTANT NOTE.   Any manual adjustment at the inner section of the Microscope, without a preliminary authorization by the manufacturer will discard the warranty option. Please do contact the manufacturer or the local vendor before you open the cover of the Microscope unit.

Each electrically operated component inside the Microscope has a more or less separated circuit board, designated for the lowest level hardware tasks. Therefore each of this components can be considered being independent peripheral devices. There is an auxiliary function of this peripherals, beyond the main function of interfacing between the central control unit and the mechanical tasks, that is the deepest level supervising over the corresponding specific job. This concept is intended to be ensured that any unwanted mechanical operation may be blocked at the deepest level of the hardware in order to protect the mechanical/hardware components from fatal damages. This protection is accomplished with a series of opto-electric sensors by means of a wired protection logic.

For example, a wired logic circuit of an opto-gate sensor blocks the power of the stepper motor whenever the related motion gets out of the normal and permitted range.

Should a mechanical action was blocked by a peripheral device, so indicating a mechanical failure, the remote Computer will stop its operation and an error message with error code will be displayed.

In order to provide the opportunity of visual inspection, each periphery and/or basic mechanical function is furnished with an indicator LED device for the visualization of its error status. If the corresponding LED is on, the related function will operate correctly. However if a LED is off, a mechanical function or a group of them will be blocked by a wired protection circuit.

Two groups of indicator LED devices are reported here. Since this are the most important in the practice of the user, in the sense of that the related kind of hardware failure likely might be repaired by the user himself easily, without any assistance by the manufacturer.

7.5.2   OPERATION STATUS INDICATORS (RADOSYS 200X VERSIONS)

7.5.2.1.1 The main error indicator on the motor-board of the Microscope unit
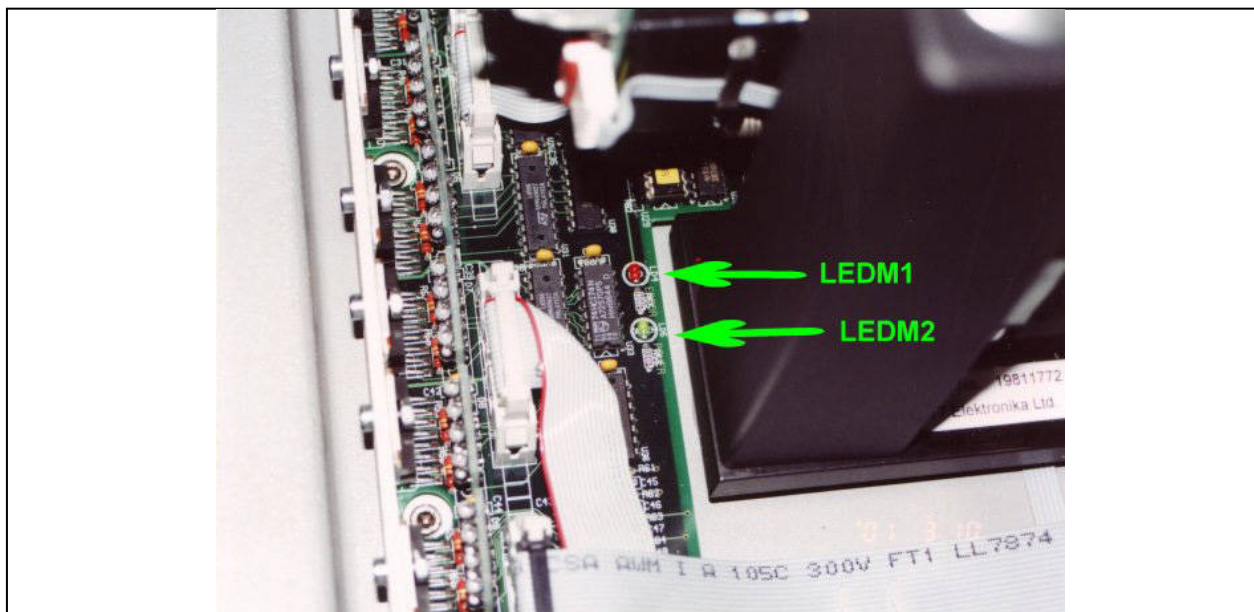
Whenever any peripheral error occurs in the Microscope unit, the LEDM1 is on and is flashing. At normal operation this LED is off

7.5.2.1.2 Group of LED indicators related to X/Y motion

Five LED indicators belong to the X-motion related operation. All of them are placed on the same circuit board, forming a line of LED indicators. At normal operation of the X-motion functions each of the five indicators are on.

Three LED indicators belong to the Y-motion related operation. All of them are placed on the same circuit board, forming a line of LED indicators. At normal operation of the Y-motion functions each of the three indicators are on.

If any of this LED indicators was off, this would intend to indicate an error position at the corresponding directional motion mechanism.

Should it happened that the indicators suggest improper operation, and the problem can not be resolvable with the guidance of the Radosys Manual, please contact to the manufacturer. This case please prepare a brief report about the status of each indicator LEDs, in order to provide help for the most accurate interpretation about the source of the problem.
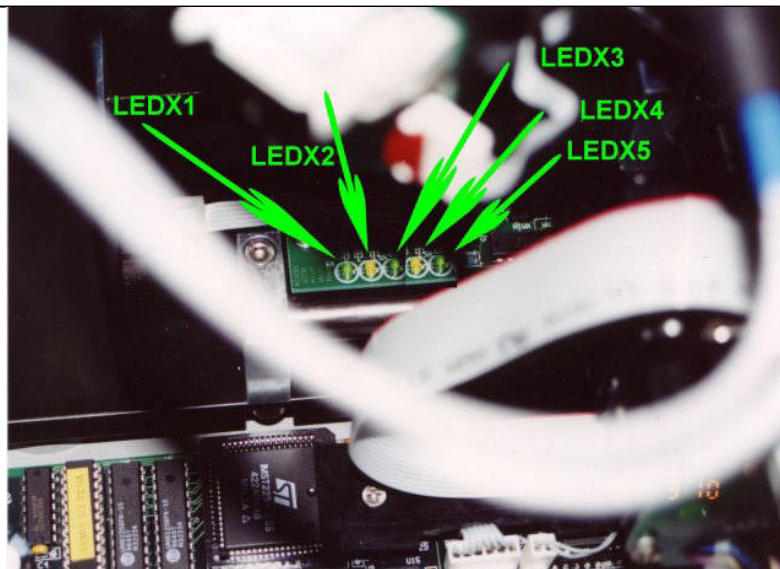
Indicator LEDs related to the X-motion. The board is located close to the X-motor. Please find a guide for the location of the X-motor at the image of the Left View of the Microscope, shown above.
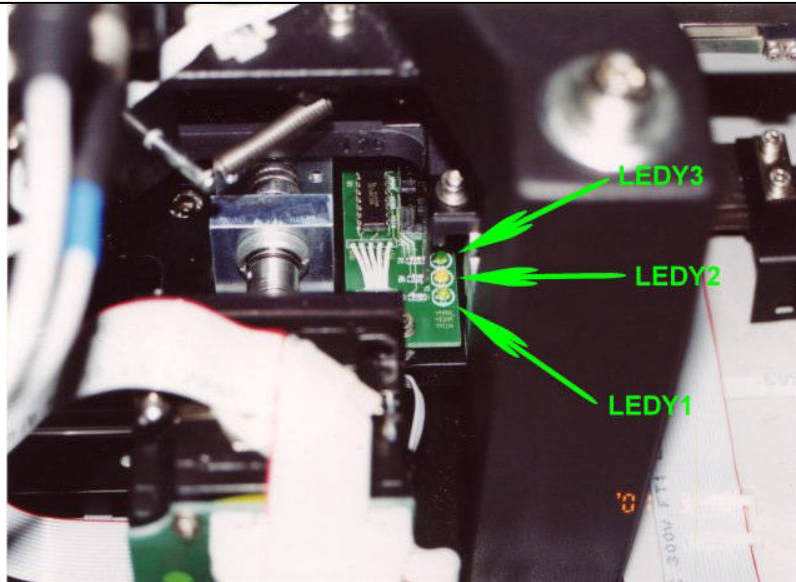
Indicator LEDs related to the Y-motion. The board is located close to the Y-motor. Please find a guide for the location of the Y-motor at the image of the Left View of the Microscope, shown above.

7.6   THE SLIDE INSERT OPERATION

General description

After the etching process, one slide assembly contains max 12 detector chips. The same slide assembly is used during the track analysis in the automated microscope. The slide is inserted into the microscope and afterwards the movement is carried out by the microscope mechanism automatically.

The mode of slide transport is different at the microscope Model RSV6 and RSV60. The number of slides, that can be inserted at once for the analysis, this makes the difference. At the RSV6 Model one slide can be inserted at once. At the RSV60 Model twenty slides can be inserted at once.

The slide transport mechanism is described here.

Slide transport operation at RSV6 Model

The insertion and removal of the slide looks like as of a credit card at a cash machine. Both the insertion of the slide and its removal after the measurement happens at the front face of the microscope, at the front slide slot.

- Slide insertion is requested by the software after invoking a user command to start the measurement.

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- The microscope advances the slide tray ahead making its insertion slot visible for the slide insertion.
- The slide is inserted into slide slot. The mechanism detects the presence of the slide and pulls the slide inside.
- Afterward the microscope mechanism manages the movement of the slide assembly inside automatically, without any manual interaction. The progress of the internal movements is visualized in the Progress Window of the software.
- When the measurement completed, the mechanism advances the slide tray ahead, making the slide slot visible together with the slide.
- The slide can be removed manually.

Slide transport operation at RSV60 Model

The insertion of the slides happens at the front face of the microscope. The removal of the slide, after the measurement is automatic and it is dropped into a container at the rear of the microscope. That is the completed slides are collected in a rear container automatically, without manual interaction.
The RSV60 model was designed for big capacity operation with automatic processing 20 slides at once. But single slide operation is also available. These modes are selectable alternatively by user commands.

The Slide Stack of the RSV60 Model Microscope

Mode of processing 20 slides at once

At this mode, the slide transport process comprises two distinguished steps.

At the first step the max 20 slides are inserted into the microscope each by each, where the mechanism arranges them into a stack. This step needs manual interaction, but just insertion of the slides into the slide slot. Building up the stack of slides is made by the mechanism automatically.

       At the second step the stacked slides are removed from the stack each by each and processed by the microscope mechanism automatically. The stacked slides are processed by Last-In-First-Out logics.

- Slide insertion is requested by the software after invoking a user command to start the measurement.
- The first slide is inserted into the front slide slot. The mechanism detects the presence of the slide and pulls the slide inside.
- The slide is advanced into the slide stack automatically.
- The next slide is requested by the software. The next slide is inserted and advanced into the stack by the mechanism automatically.
- The slide insertion process is repeated until the insertion of the slide number 20 or until the user instructs the software to stop building the stack more.
- Afterward the microscope mechanism manages the movement of the slides inside automatically, without any manual interaction. The progress of the internal movements is visualized in the Progress Window of the software.
- Whenever the analysis of a slide accomplished, the slide is advanced by the mechanism to the rear container automatically.
- When the slide stack gets empty and all the formerly stacked slides dropped into the rear container, the process gets completed.
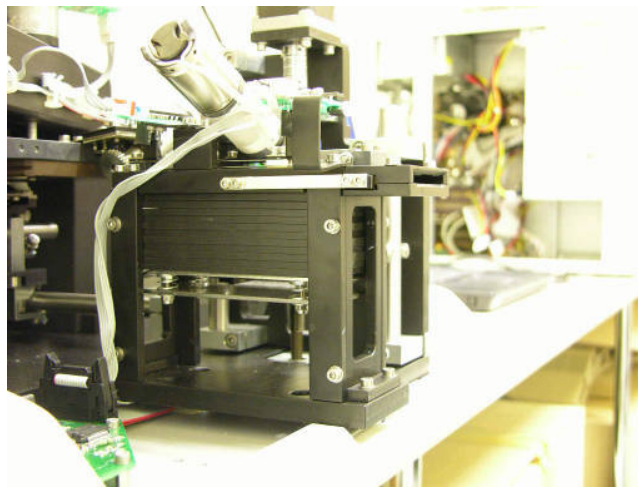

Mode of processing 1 slide at once

- Slide insertion is requested by the software after invoking a user command to start the measurement.
- The slide is inserted into the front slide tray. The mechanism detects the presence of the slide and pulls the slide inside.
- The slide is advanced to the position of analysis inside automatically. At the case of single slide processing the slide stack is not utilized by the mechanism.
- Whenever the analysis of the slide accomplished, the slide is advanced by the mechanism to the rear container automatically.

7.7　RB4 ETCHING UNIT

Two regional subversions are available for the RB4 etching units.
- Units for 100V power standards, with USA/Japan power cord&plug.
- Units for 240V power standards, with EU Continental power cord&plug.
The performance of these regional subversions is fully identical, with one exception only. The warming up time at the 240V version is much shorter, because of the greater power rate of the heater component.

RB4-111 Warming-Up Graph
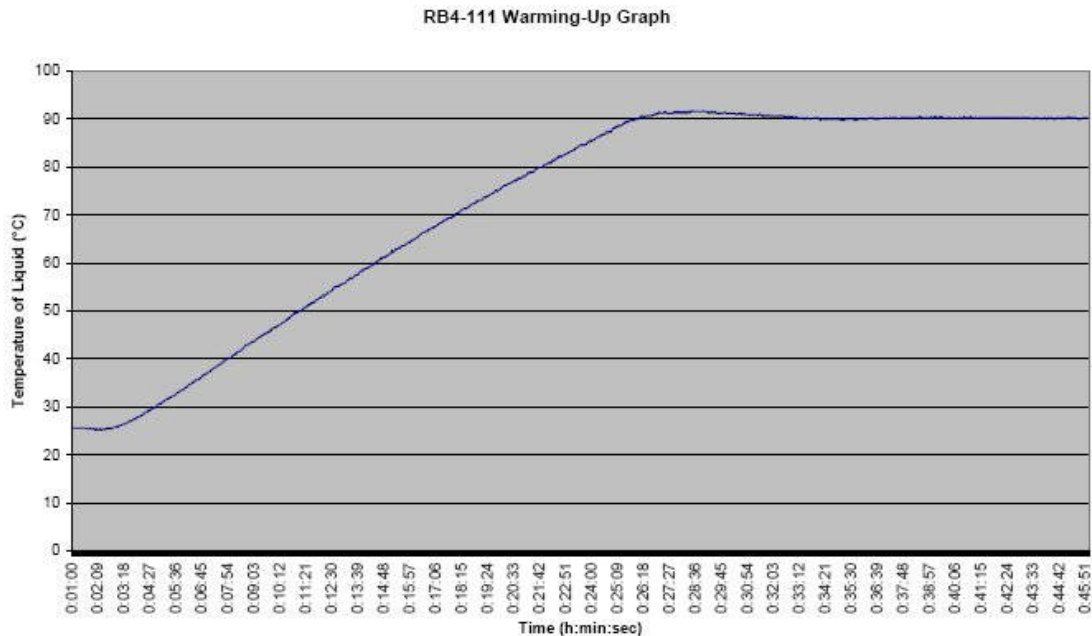
Typical Warming-Up characteristics of the 240V version RB4 unit.

7.8   RADOSYS SOFTWARE RELATED ENGINEERING DETAILS

7.8.1   MENU CHART OF THE RM VERSION SOFTWARE (RSV6 MODEL)
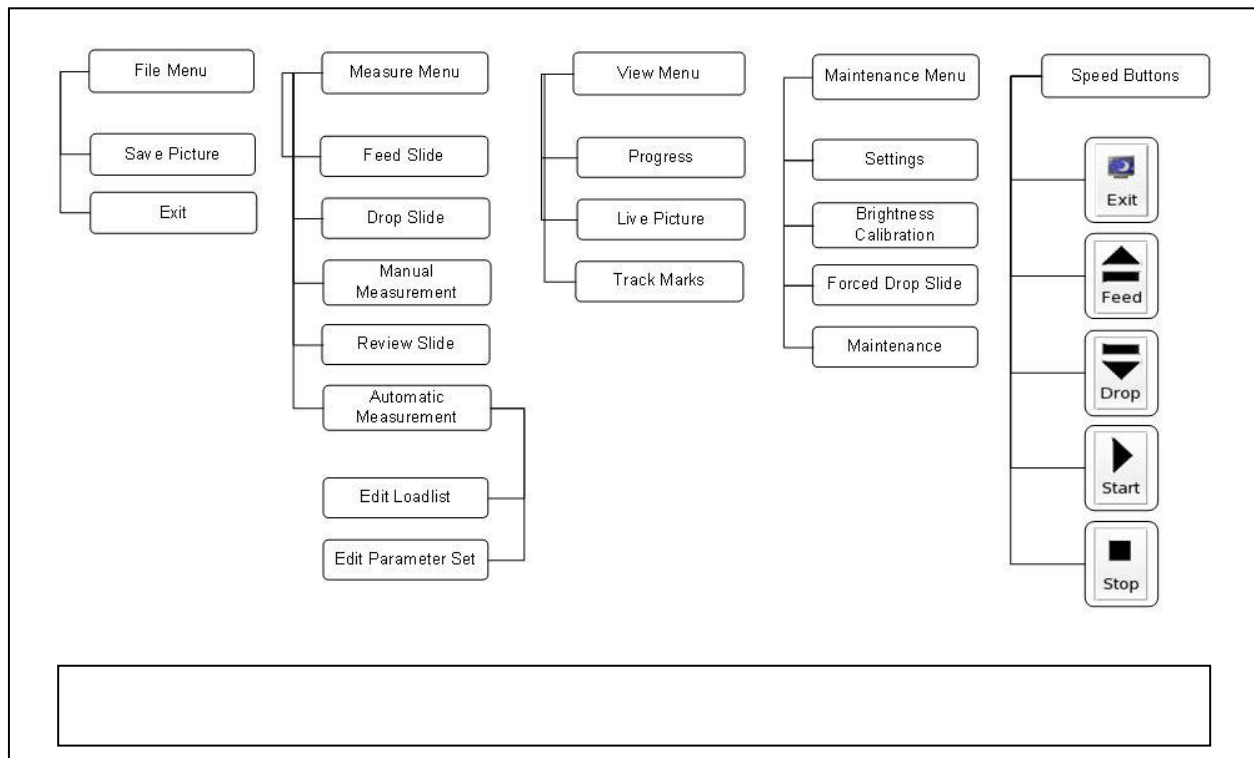
7.8.2   INFORMATION ABOUT THE RADOSYS TRACK COUNTING CONCEPT

7.8.2.1 General information and also about the scientific background

There are two Radosys's product lines today, where the Radosys Etched Track Reader system is utilized.
RADOMETER product line, which is dedicated to medium/big size radon surveys.
N-DOSYS product line, which is dedicated to individual neutron dosimetry.
At equipments, units and accessories there is a big similarity, but at certain units, the difference is significant, since these product lines belong to different application areas. However at the level of general overview, the common part of the operation can be discussed without disturbing the clarity of understanding. These common details are overviewed below, nevertheless whenever is necessary the differences are noted.

7.8.2.2 Main Units and Components

Automated microscope and control computer, [for instance, version RS-V6 as the latest version to date of January 2006]

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Track development, Etching Unit, [for instance, version RB4 as the latest version to date of January 2006]
LINUX Operational System, which hosts the application software and the hardware interface to the microscope

Application specific components:
Radometer application:
RS-RM type application software, track recognition software, version V1.3
Radon detectors, various types
N-Dosys application
RS-TA type application software, track recognition software, version V1.4
Pre-Treatment unit, [for instance, version PRV6 as the latest version to date of January 2006]
N-Dosys type personal neutron dosimeters

7.8.2.3 The principle of the Statistically Stable Track Reading Approach

7.8.2.3.1 Historical overview

In the history of the solid state nuclear track detectors, SSNTD, at the pioneer ages, the nuclear tracks were counted by means of common, manually operated laboratory microscopes. The microscopic objects were evaluated and counted visually. After a time of practicing the observing person learnt how to qualify an object being a nuclear track. Trying to achieve the best accuracy and safety, virtually all track-like objects were qualified as nuclear tracks. Because of the nature of this kind of visual track reading, the counted number of tracks might vary from person to person, also from time to time at the same detector. The achieved accuracy was satisfying for basic research, but from point of view of metrology's requirements this way could not meet the overall demands at nuclear dosimetry, or at least the achievable accuracy and repeatability were limited.

The introduction of the commercially available automated track reader systems, at late 80's, started a new age at the routine application of SSNTD. The automatism itself naturally increased the throughput, so it made possible fast processing even many thousands   of   detectors.

At the same time the automatism brought also other advance, that the track recognition got a definite character. An automated track reader system recognizes a track by a set of criteria, which makes definite decision about each microscopic object, if this could be qualified as a track. This feature enhances the repeatability, and consequently, also the accuracy   of   track   counting.

Up to this point all the automated track reader systems work with similar approach. But in the practice, there are many differences among the existing systems at their performance.

A typical track reader system recognizes the tracks in one step and uses fixed set of criteria at recognition. This approach attempts to recognize virtually all tracks with a

recognition threshold being as low as it was possible. By other words, this approach tries to reconstruct the visual method but on automatic, by-machine platform. This approach, mistakenly, intends to gather as many tracks as possible, using minimized tolerance, in order to achieve the maximum accuracy. But this concept is based on improper presumption that the accuracy is increasing by decreasing the recognition threshold. In the reality, at the region of lower recognition thresholds, the quality of the track's image is so bad that their contribution rather makes the standard deviation worse, so it does not improve the accuracy at all.

On the other hand, at a typical track reader system, the speed of track counting is determined simply by the time, which is needed to deal with all the microscopic objects, and consequently without any chance to optimize the process by the user.

7.8.2.3.2 The Radosys's concept of track recognition technology

The Radosys's track counting technology is based on the observation that a portion of tracks provide uncertain quality of microscopic images, and that these tracks do not contribute to the accuracy beneficially. These tracks can be ignored, and this ignorance may even enhance the accuracy, moreover also the process speed is much faster. A typical representative of the "uncertain" tracks appears with poor image contrast or its size takes place at the tail of the size distribution diagram.

The Radosys's track reader algorithms were developed in light of realizing those important observations. It was deducted that the statistical stability of track counting was more important than to count all the tracks. In other words, the repeatability performance at the counted track density is more important than to deal with each potential track image. It is important to emphasize that the ratio of the ignored track-like objects is just a small portion, say 10%. But this small portion is able to influence on the achieved imprecision, standard deviation, significantly.

The legality of this approach is understood better when the importance of the calibration is considered.
The calibration factor establishes definite relationship between the counted track density and the physical value to be measured, for instance equivalent dose or radon activity concentration.
Any dosimeter application should be accompanied with a proper system calibration. Actually, the characteristics and performance of the calibration work is decisive at qualification of a dosimeter system, regardless of what kind of details have led to the good performance.
The calibration factor is a combination of various contributing factors, related to the structure of the dosimeter, also the etching process and also the track counting algorithm. These individual contributions can not be separated in the practice and only the overall calibration factor can be determined. Therefore the way of the track recognition is just one of the contributing factors. This is the main reason that

The Radosys's track reader concept votes the technology of optimized recognition threshold, contrary to that of the minimized fixed threshold.

This concept is equipped with the following features:

The recognition threshold is set to a reasonable level, in order to avoid contribution from those tracks, which perform uncertain quality of microscopic image.

The track recognition is carried out by two-steps process, where the "unwanted/uncertain" tracks are filtered out by the lower level of the image processing algorithm.

EPS to adjust the threshold by the user

Possibility for optimizing speed and accuracy

Main target principle: Recognition of all tracks is not necessary. The statistical stability of track counting is more important than to count all the tracks. Repeatability performance at the counted track density is more important than to deal with each potential track image. The ratio between the counted and the uncounted tracks should be stable statistically; this is the proper requirement. This ratio can be considered, involved in the calibration process.

This concept is able to provide a very good throughput for routine analysis.

RM and TA software versions are different. The way of prefiltering are different. At RM circular arcs are fitted by the low level image processing algorithm.

Autofocus operation by software.

7.8.2.3.3 The concept of Detector's Batch Processing

- One of the key components of the system is the inexpensive, disposable holder card, "slide", which is used during both the development process and the track analysis. The detector chips are inserted into slides after the exposure and they remains in the slide permanently, so even after the completion of the whole process. Therefore this concept also supports archiving the detectors. The analysis can be repeated on the archived detectors later again.

7.8.2.3.4 The N-DOSYS's unique track enhancement technique for neutron detection

A Radosys's propriety technology is used for fast neutron detection. The essence of this technology is that the latent tracks are made more visible and/or enlarged by pre-treatment in carbon-dioxide. The pre-treatment is a requirement before the main etching step by sodium-hydroxide.

For details about the scientific details of the pre-treatment technique please refer to an article, as follows:

Hulber, E. and Selmeczi, D. 'Counting recoil proton tracks on PADC without pre-etching step ..', in Radiation Measurements, Vol. 40/2-6 pp. 616-619.

7.9   Calibration Concepts

7.9.1   General Information

7.9.2   Interpretation of Terms (DMU-V99 Version)

Interpretation of terms for the calculation of the calibration factor of the Radosys

The relationship between the counted track density and the physical values is interpreted by the next equation.

$$D = \int sR(t)dt$$

Where

D= track density [mm^{-2}]
s= sensitivity [$(kBqhm^{-3})^{-1}mm^{-2}$]
R= Radon Activity Concentration (RAC) [Bq/m^{-3}]

The factory default value of the overall sensitivity of the Radosys is

S= 2.588×10^{-2} $(kBqhm^{-3})^{-1}mm^{-2}$

The contribution by the next factors are comprised in this value primarily:
Alpha registration sensitivity of the CR-39 chip
Characteristics of the Radopot diffusion chamber
Track recognition characteristics of the Radosys 2000 software

The DMU data analysis sw unit of the Radosys 2000 counts the time of the exposure in days. Day is the input data for the length of exposure. Therefore the recalculated form of the equation may be more useful in the practice:

D [mm^{-2}]= $6.21 \times 10^{-2} \times R[Bq/m^{-3}] \times T[day]$

When the DMU calculates the RAC value from the counted track density, the inverse function is applied. Actually, the next type of calibration equation is displayed in the Calibration Set menu of the DMU.

RAC=A*Density+B

At the "factory" default calibration set the value B=0.
The value A is the inverse of the factor in the previous equation for D.

A=1610=$(6.21 \times 10^{-2})^{-1}$

Dimensions:

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$RAC=[Bq/m^{-3}]$
$A=[Bq/m^{-3}mm^2]$

7.9.3 CALIBRATION DATA EXCHANGE AT DMU-V6R VERSION

7.10 SCIENTIFIC BACKGROUND OF THE N-DOSYS NEUTRON DOSIMETER APPLICATION

The scientific background and principle of this application is introduced by a slide presentation here.

The content of this chapter have been removed from RS_Man63, because of its large file size. At printed or PDF version of this Manual this chapter is attached to the end of this document.

7.11 ESTIMATION OF UNCERTAINTY OF RADON MEASUREMENTS WITH ALPHA TRACK DETECTORS – THEORETICAL APPROACH

Exposure (*E*) is calculated using the following formula:

$$E = \left(16 \cdot e^{CF} \cdot \frac{D - BG}{\sqrt{A - A_0}}\right)^{1/k}$$

where *CF* and *k* are the two calibration factors (slope and exponent) calculated by the DMU software, *D* is the measured track density, *BG* is the background track density, *A* is the average track area on the detector and A_0 is the offset parameter associated with track area, with which we can also influence the weight (significance) of the track area correction. The logic behind this correction is explained below.

⚞ In the automatic track counting process only those tracks are counted that fall within a certain size range.

⚞ If the average track size is bigger than normal then some smaller tracks, which would normally be excluded from the track counting process, may fall within this size range and therefore will be counted.

⚞ If the average track size is smaller than normal then some tracks, which would normally be counted by the microscope, may fall out of the above size range and therefore will not be counted.

⚞ The upper limit of the accepted size range is set so that it does not affect the track counting process in case of slight variations in the average track size.

The denominator in the above formula $(\sqrt{A - A_0})$ serves as a correction for this phenomenon (the factor 16 was chosen so that the corrected track density falls into the same order of magnitude as the original track density).

According to the propagation of uncertainty, the uncertainty of exposure is estimated by the following formula (standard deviation is denoted by the symbol D(.)):

$$\mathrm{D}^2(E) = \left(\frac{\partial E}{\partial CF}\right)^2 \cdot \mathrm{D}^2(CF) + \left(\frac{\partial E}{\partial (D - BG)}\right)^2 \cdot \mathrm{D}^2(D - BG) +$$
$$+ \left(\frac{\partial E}{\partial A}\right)^2 \cdot \mathrm{D}^2(A) + \left(\frac{\partial E}{\partial k}\right)^2 \cdot \mathrm{D}^2(k). \tag{1}$$

Here we assume that the parameters *CF*, *D - BG*, *A* and *k* are uncorrelated.

In order to write the term D^2(*D - BG*) in a more explicit form, let's go step by step through the process of track creation.

⚞ There is some radon concentration inside the diffusion chamber. (This is what we want to determine.)

⚞ At the beginning of the measurement the track density on the detectors is not zero, there is some background density. It has a little fluctuation, so the exact *background track density* is a random variable.

⚔ During the measurement some of the ^{222}Rn atoms (and its progeny) will decay and emit alpha particles. However, at a given activity the number of emitted alpha particles cannot be determined precisely as radioactive decay is a statistical process. So the *number of emitted alpha particles* is also a random variable.

⚔ The spatial distribution of the radon atoms within the diffusion chamber can vary from chamber to chamber. The directional distribution of alpha particles is supposed to be homogeneous but it also has an uncertainty. These two parameters influence the number of alpha particles that can reach the detector surface. Moreover, if the same number of alpha particles reach two different detectors then the number of tracks (and the track density) produced on the detectors will not be identical because their sensitivity is slightly different. So given a certain number of decays (i.e. alpha particles), the resulting *actual net track density on the detector* (which is a well defined quantity) is itself a random variable.

⚔ Finally, we have to count the tracks on the detectors, which has some uncertainty. So the counted number of tracks and hence the *measured track density* is also a random variable.

Based on the above train of thought, the track density can be written as:

$$D = BG + \sigma \cdot \xi + \eta,$$

where

⚔ *BG* is the background track density

⚔ ⬧ is the number of decays (i.e. alpha particles) within the diffusion chamber during the measurement. It obviously depends on the exposure (the product of radon concentration and duration of measurement).

⚔ ⊠ is the ratio of the actual net track density produced on the detector and the number of alpha particles emitted within the diffusion chamber during the measurement. This ratio can be called the *detector sensitivity*.

⚔ ∿ is the measured track density minus the actual track density on the detector. Thus, if the counting equipment works properly, the expectation value of ∿ should be zero.

Therefore

$$D^2(D - BG) = D^2(D) + \frac{D^2(BG)}{n} =$$

$$= \left(1 + \frac{1}{n}\right) \cdot D^2(BG) + \sigma^2 \cdot D^2(\xi) + \xi^2 \cdot D^2(\sigma) + D^2(\eta) \quad (2)$$

where *n* is the number of background measurements, from which we determined the average background level to subtract.

Substituting equation (2) into equation (2) we get

$$D^2(E) = \left(\frac{\partial E}{\partial CF}\right)^2 \cdot D^2(CF) + \left(\frac{\partial E}{\partial A}\right)^2 \cdot D^2(A) + \left(\frac{\partial E}{\partial k}\right)^2 \cdot D^2(k) +$$

$$+ \left(\frac{\partial E}{\partial (D - BG)}\right)^2 \cdot \left(\left(1 + \frac{1}{n}\right) \cdot D^2(BG) + \sigma^2 \cdot D^2(\xi) +\right.$$

$$\left. + \xi^2 \cdot D^2(\sigma) + D^2(\eta)\right). \quad (3)$$

Now let's calculate the above partial derivatives.

$$\frac{\partial E}{\partial CF} = \frac{1}{k} \cdot E,$$

$$\frac{\partial E}{\partial (D - BG)} = \frac{1}{k} \cdot \frac{E}{D - BG},$$

$$\frac{\partial E}{\partial A} = \frac{1}{2k} \cdot \frac{E}{A - A_0},$$

$$\frac{\partial E}{\partial k} = \ln\left(CF' \cdot \frac{D - BG}{\sqrt{A - A_0}}\right) \cdot E \cdot \left(-\frac{1}{k^2}\right) =$$

$$= -\ln(E^k) \cdot E \cdot \frac{1}{k^2} = -\frac{E \cdot \ln(E)}{k}.$$

Substituting these formulas into equation (3) and deviding by E^2 we get

$$\frac{D^2(E)}{E^2} = \frac{D^2(CF)}{k^2} + \frac{D^2(A)}{4k^2 \cdot (A - A_0)^2} + \frac{\ln(E)^2 \cdot D^2(k)}{k^2} \tag{4}$$

$$+ \frac{(1 + 1/n) \cdot D^2(BG)}{k^2 \cdot (D - BG)^2} \tag{5}$$

$$+ \frac{\sigma^2 \cdot D^2(\xi)}{k^2 \cdot (D - BG)^2} \tag{6}$$

$$+ \frac{\xi^2 \cdot D^2(\sigma)}{k^2 \cdot (D - BG)^2} \tag{7}$$

$$+ \frac{D^2(\eta)}{k^2 \cdot (D - BG)^2}. \tag{8}$$

The first three terms (4) of the sum represent the uncertainty of the calibration, which is governed mainly by the uncertainty of the exposure given to the detectors by the calibration facility. The next term (5) represents the uncertainty of the background track density. The next term (6) represents the uncertainty in sheet sensitivity. The next term (7) represents the uncertainty due to counting statistics. The last term (8) represents the uncertainty of the readout.

If we are only interested in the gross uncertainty (and not the different kinds of it) then the following formula is more helpful:

$$\frac{D^2(E)}{E^2} = \frac{D^2(CF)}{k^2} + \frac{D^2(A)}{4k^2 \cdot (A - A_0)^2} + \frac{\ln(E)^2 \cdot D^2(k)}{k^2} +$$

$$+ \frac{D^2(D) + D^2(BG)/n}{k^2 \cdot (D - BG)^2}.$$

8 Installation

8.1 UNPACKING

The instrument is shipped in three packages. The Operator's Manual is enclosed in the box of the Microscope Unit box. It is essential to open this box first in order to read the Operator's Manual and to act accordingly.

Use a knife, a pair of scissors or a scalpel to open the boxes. Cut the tape only, leaving the carton material intact. Do not attempt to open the boxes with blunt objects, and only cut the seals where necessary. Remove, but do not discard, the packing materials from the box. Then lift out the equipment. When lifting, hold the Microscope Unit and the Electronics Unit under the rim of each unit's base rather than by the upper covers. The pieces lifted must be placed on their feet only. Open the sealed protective plastic foil and take out the units. Do not forget to take the accessories, such as cables, tools and floppy disks, out of the box. Account for all contents, comparing against the packing list.

Keep all insulating and packing materials in the boxes. Save them, in case the instrument needs to be moved to another location or must be shipped to the manufacturer for service. Never move the RadoSys without the proper boxes and packing materials. If the original packing material from the manufacturer is lost or damaged, order a new set from the distributor of the instrument.

In order to repack the RadoSys, follow the reverse order. Before repack, remember to reinstall the plastic protective insert (see section Pre-Installation Procedures) in the slide insertion slot of the Microscope Unit. Cover the equipment with the plastic foil, reinsert the desiccant and seal the foil with self-adhesive tape. Place the units in their own boxes, with their feet down, remembering to lift them from under their bases. Replace the accessories in the box and add the packing materials. Seal the boxes with tape.

8.2 PRE-INSTALLATION PROCEDURES

The following step must be taken prior to installation, once the RadoSys Microscope Unit has been unpacked and positioned in the place of its intended use.

Pull the plastic protective insert out of the slot on the bubble-like plastic cover.

The Power Converters of the Microscope and of the Computer Unit must be connected to the power network by a power cable matching to the local standards and with Ground wire feature only.

8.3 INSTALLATION PROCEDURE OF THE MICROSCOPE AND THE COMPUTER UNITS (RSV6X)

8.3.1 INTRODUCTION

In this section the steps required to install the RadoSys are specified. Please follow the instructions carefully, verifying that the cables are plugged in correctly and that the mains voltage setting is correct.

8.3.2 MICROSCOPE AND CONTROL COMPUTER

- Place the Microscope and the Notebook computer to a desk. Interconnect the units by USB cable. For the installation of the battery to the Notebook and interconnecting to main power please refer to the Manual of the Notebook. Interconnect the Microscope to the main power by means of the 24V Desktop Power Supply.
- Switch on the notebook control computer
- Power up the microscope. (For units delivered before April, 2006.)
- The microscope is powered up automatically. (At units after April, 2006.)

- When the login window is displayed, login to the system as follows:
User: rm
Password: rm
Now the system is ready to start the track analysis application software.

Warning.
Please consider that the password is case sensitive in Linux. The Linux distinguishes capital and normal characters.
Note: At certain password entering fields, the typed characters may remain invisible. Whenever this happened the password should be typed by blind way.

8.3.3 GENERAL COMPUTER RELATED INFORMATION

The Control Computer is HP-Compaq nx6110 type notebook. This computer was purchased from a local retailer with English keyboard, without pre-installed OS, and with one year worldwide guarantee. Before the delivery of the system, the computer was removed from its original package and Linux OS and Radosys application software items were installed to this. The rest of the Computer package left intact. The battery was not used during the software installation, therefore this is intact and please refer to the original, HP-Compaq's instruction for the installation of the battery. The original, nx6110 package was not dedicated for Linux operation, but for general usage. Therefore

Chapter 8. _____   **Installation**

some accessory items, for example add-on cables or driver CDs enclosed may be useful for Windows operation only.

8.3.4 COMPUTER CONFIGURATION SPECIFIC INFORMATION

- (Applicable for systems delivered <u>without</u> Double OS Configuration Option)

During the software installation the originally empty Hard Disk was partitioned mainly for Linux OS operation. But optionally, for extension purpose by the user, an MS-DOS partition was also added. If installation of Windows system was desired by the user, this MS-DOS partition should be used for this purpose and all the other, Linux specific partitions should be left intact. Whenever a Windows OS is installed to the computer and the Windows setup program intended to reformat or repartition the Hard Disk, simply response NO. Only those versions of Windows Setup programs are welcomed, which provides definite information about that the existing partitions would be left intact. Never use OEM type Windows installation CD for this purpose.

- (Applicable for systems delivered <u>with</u> Double OS Configuration Option)

When the system was delivered with both Linux and Windows XP Pro double configuration, the Windows OS and the Linux OS are both available to start up alternatively at the time of powering up the computer. An extra HD partition was implemented for data exchange between Linux and Windows operation. This HD partition is available, as a logical drive, to read and write under both OS.
Be careful at installation of any application software under Windows OS control and install only that software, which comes from reliable software vendor. Especially avoid any application software, which could change the structure of the HD partitions. The integrity of the whole system is secured the best when Administrator level of operation is avoided during Windows operation.
See also Warning 8.

8.3.5 WARNINGS

- When the interconnecting USB cable is disconnected between the Microscope and the Computer, or when the connector is loosen, the connection is not recovered by the system automatically, but an error message is displayed. At this case restart the X-Windows subsystem of the Linux OS.

- For the USB interconnection between the Microscope and the Computer never use USB HUB or similar router device. But use the unit's own USB sockets directly in order to secure the stability of the communication.

- The software system of the notebook type Control Computer is delivered in completed, ready-to-use condition. Adding more application software or Windows OS is permitted, but only with particular care. No any operation is permitted, which may modify harmfully or destroy the installed Linux system or its HD partition structure. Only a professional,

expertise computer technician is able to add alternative OS, for example Windows, to the computer with safety and without effecting on the functionality of the original setup risky. The supplier of the system, Radosys Ltd does not admit any responsibility if this strict rule is failed or neglected in any respect.

- (Applicable for Microscope units delivered before April, 2006.) When the computer is switched off, this does not switch off the power supply of the Microscope automatically. The power supply of the Microscope should be switched off manually.
(All the Microscope units delivered after April, 2006, those were equipped with automatically controlled power switching off feature.)

8.4   SOFTWARE UPGRADES

The software upgrades are supplied by email or by means of CD.
Please notice that the install procedure for RSV6X system versions is different.

8.4.1.1.1 Files on CD

Should the software upgrade **received on CD**, this CD provides an automatic installation as follows.
- Start up the Radosys notebook type control computer and login as rm user as usually.
- Insert the CD to the drive of the computer.
- The computer starts up the CD automatically.
- The window "Suse Hardware Detection" is displayed and
- The query "Start the media script?" is displayed in the window.
- Click on the button OPEN.
- A text window is displayed with the request:
Please enter the root password below!
Enter the root password and press ENTER:

RMet2000

This is the root password of this Linux system. Please consider that the password is case sensitive in Linux. The Linux distinguishes capital and normal characters.
Note: When the root password is entered, the typed characters are invisible.

- When the root password entered correctly, the next message is displayed

Installing Radosys Manual…
UPDATE xx
Press Enter to close this window.

8.4.1.1.2 Files by Email

Should the upgrade file **received by email**, this should be copied to a removable media, to floppy disk or CD. To invoke the upgrade, insert the media to the Control Computer and click on the Desktop icon Run_RadoSript. The Radometer software scans all the

Chapter 8.   _____   **Installation**

available removable storage devices searching for upgrade files and when one found the upgrade installation is done automatically.

When the root password is requested by the Installation software, please enter:

RMet2000

This is the root password of this Linux system. Please consider that the password is case sensitive in Linux. The Linux distinguishes capital and normal characters.

Note: When the root password is entered, the characters typed are invisible.

8.5 INSTALLATION PROCEDURE OF THE RB4 ETCHING UNIT

- Place it to a plastic tray. Remove the packaging materials. Interconnect it to the main power outlet.

- The next type of chemicals are needed for the etching process.

- 1000 g of crystalline sodium-hydroxide with Puriss-Anal quality for the etching bath. Available at any fine-chemical dealer. The size of the granulates (pellets) can not exceed the 10 mm. The size of the granulate is limited by the diameter of the filling funnel.

- 4000 ml of finely distillated water for the etching bath. The puris-anal quality is not a requirement, it does not worth to apply this expensive sort of chemical water. However the application of the water produced by a real distillation machine is highly recommended to achieve the optimal performance. The application of any industrial quality purified water, that is ion-exchanged or reverse-osmotic purified water should be avoided.

-Note: The RB4 Type Etching unit does not need external power adaptor accessory. The whole unit operates by connecting it to the power network by means of its main power cord.

**8.6 INSTALLATION PROCEDURE OF THE RADOBATH 99 ETCHING UNIT**

Remove any packaging material from the inner space of the bath container.
Place the main etching unit onto a laboratory tray. Usage of the tray is an important safety requirement. The tray collects some of the overflowing volume of the bath solution. Normally, any overflow of the fluid is unexpected, if the usage is carried out properly. However some leakage of the fluid occurs at the time of opening the bath cover after heating. This small amount of fluid leakage is created by vapor deposition at the inner surface of the bath cover. Select the height of the tray as big that it could catch one liter of fluid at least at the case of emergency overflow.

Connect the main power cord of the adapter into the wall socket. The motor power circuit does not contain any power switch, therefore the motor starts its operation at the time of the power connection instantly. It is convenient to use a multi-socket electric power distributor with mains switch in order to switch the power on or off. Connect the mains cord of the bath heater unit to the wall socket or to the multi-socket power distributor.

Connect the low-voltage plug of the motor power adapter cord into the socket at the rear of the bath cover section.

Insert the silicon drain tube onto the outlet of the drain tap.
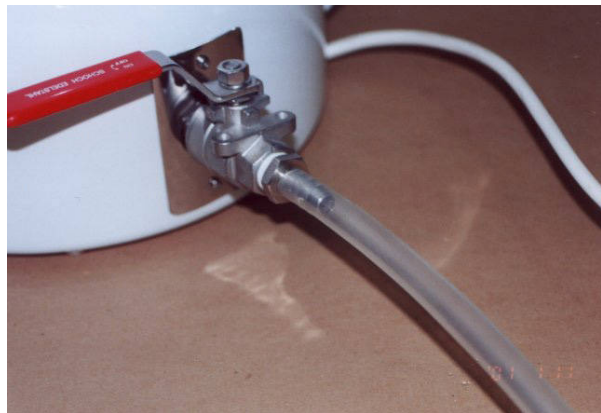
The heater can be switched on by the tumbler switch on the lower front section of the equipment.

9   Maintenance and Troubleshooting

9.1   KNOWN SOFTWARE BUGS OR OTHER MALFUNCTION, SEEMINGLY SOFTWARE BUG

9.1.1   IMAGE CAPTURE RELATED MALFUNCTIONS

At normal start-up of the system, the main microscope image window is gray. If this was black this might indicate malfunction of the image capture subsystem.

But please check the software settings before you warn about this kind of malfunction. There is one software settings, which also may cause the main window black at start-up, but which is a normal operation. When the "Track Marks" operational mode was selected before the previous system shutdown, this setting was stored. This case, the next system start-up applies the same system setting in this respect. The main image window remains black until the actual track counting process started. This means that at "Track Marks" option the image is refreshed at first, only during the track counting process, actually when the first tracks are recognized.

9.1.1.1.1 The main microscope image window stays black after system start.

This may happen when some system settings at LINUX OS level have been altered.
- One of this occasion may happen, which is not a typical one, when the user with system administration access rights, (as root user), alters some related system settings.
- However, also other occasion may happen, when the user alters the image capture related system settings unintentionally, which has been already occurred many times unfortunately. The standard installation of the LINUX system includes also a series of utility software, utilizing the same hardware channels, which is dedicated to the operation of the Radometer software. All of these sort of utility software are related to video capture operations, for example TV or digitalization of external video sources. It is highly recommended to avoid utilizing the Radosys system for other, video operation application, but only for this application exclusively. Invoking any video capture related utility software may cause serious interference with the Radometer application. At most cases the system setting alteration by video utility software is irreversible. The Radosys system's software engineers can not protect the system configuration from this kind of alteration at Linux system level. Just please do not invoke any video application software at the Radosys system.

9.1.1.1.2 The main microscope image window stays black after system start.

A known but not yet resolved type, occasional system fault.
An occasional, rarely occurring system start-up fault has been detected.
- Description of the potential error condition:
At starting up the computer and starting the Radometer software, the main Radometer microscope window remains black, without proper image capture condition.
- Suggestion for problem resolution:
Switch off the computer by normal Shut Down operation.
Unplug the USB cable than plug it again after 10 seconds.
Wait 10 seconds and start the computer again.
This procedure always recovers the proper operation.

Chapter 9. _____ **Maintenance and Troubleshooting**

9.2   TROUBLESHOOTING

9.2.1   WHEN CLOSING THE X-WINDOWS FAILS

Any malfunction at the operation of the X-Windows system is unlikely, since this is an extremely stable environment. However any time when an unexpected and unwanted freezing of a process or of the X-Windows occurs, the X-Windows graphics environment can be restarted easily. This is a unique feature of the X-Windows.

To restart the X-Windows press the keys Alt-Ctrl-Backspace simultaneously.
The graphics environment starts again by displaying the login window.

9.2.2   DEBUG INFORMATION FOR THE SYSTEM SERVICE (RADOSYS VERSION 2000/2003 ONLY)

RELEASE NOTE: This chapter is applicable for versions Radosys 2000/2003 only. All the versions released after October, 2005, the software was equipped with integrated Diagnostics software tool. Omit this chapter if you use a Radometer software version introduced after October, 2005.

Any time when any irresolvable problem at the system operation should occurred, please create an information file for your Radosys dealer as follows.

Create and send a few of log file to the dealer.
In order to help the expert to track what happens in your Radosys computer after powering up. This log files will be analyzed and will be tried to locate the source
of the problem remotely.
Please create this log files according to the following steps.

1./ Start the RadoMeter software, not by the desktop icon, but in the
following way:
   Open a Terminal Window. (By clicking on the black monitor icon at the
taskbar, which is located at the bottom edge of the window.)
   Type the following command in the Terminal Window:
      /radosys/RadoMeter/bin/rm >> rm.log 2>&1
      (this command will redirect the messages printed on the screen to
the
rm.log file.)

2./ In the Maintenance menu, select Settings...
At the last line of the window: the "Logfile detail level" input field can
be found. Please increase this value to 5.

3./ Start the evaluation by clicking on the Start button. If any unwanted
event, that is an obvious malfunction occurs, perhaps the crash of the
Radometer sw, please close its window. If you find it better to do, please

Chapter 9. _____ **Maintenance and Troubleshooting**

locate the Logout option of the KDE environment popup menu with the first icon at the left bottom corner. Select Shutdown and the Restart option.

4./ Please locate and send us the following files by email:
   /var/log/messages
   /home/rm/.RadoSys/radometer.log
   /home/rm/rm.log

The most easiest way of sending this files, if you copy them to a floppy disk and you send them by the usual way. You may copy the files to a floppy disk by the MC, Midnight Commander. This is a Norton Commander clone, and this is a standard utility in your Radosys computer. Probably you know the Norton Commander or the Windows Commander, all of this software work the same alike. In your LINUX system, the most easiest way to invoke the MC, if you open the Terminal window and simply type "mc".

9.2.3 DEBUG INFORMATION FOR THE SYSTEM SERVICE (RADOSYS VERSIONS RSV6X)

RELEASE NOTE: This chapter is applicable for versions Radosys RSV6X. All the versions released after October, 2005, the software was equipped with integrated Diagnostics software tool.

The Diagnostics software tool is available in the Maintenance menu of the Radometer software.
………………………

9.3   CODE READING CALIBRATION

RELEASE NOTE: This chapter is applicable for Radometer software versions lower than 1.17 only. From the version 1.17 release at November, 2004, the later versions were equipped with automatic code reading calibration. Omit this chapter if you use Radometer software version 1.17 or higher.

The fine adjustment of the automatic dot code reading capability is described here.

This calibration procedure is needed when any of the following events occurs.
Transportation of the Radosys Units.
Replacement of the Microscope Unit.
The number of false reading at the detector ID code is increasing dramatically.

During the calibration procedure a correction factor for the X-Y position settings is determined by means of a Position Test Card. The Test Card is a standard accessory

item delivered with the Computer Unit. Actually this item is a standard RadoSlide detector holder with a specially prepared detector chip located in the position 2. A rectangular valley with definite position is engraved into the surface of this test chip.

Start the Radometer software.
Click on the Feed button and insert the Position Test Card into the Microscope.
Enter to the Manual Control mode.
Move the microscope head to the detector position 2 by clicking to the number 2 at the right of the Manual Control window.
Start the Autofocus operation of the Manual mode.
Search the image of the rectangular object by means of the movement control buttons. You may increase the movement step size in the corresponding input field if it is necessary.
Move the rectangular object to the middle of the image window. Set the Step Size to 1 in order to achieve the finest positioning.
After proper positioning the rectangle to the middle open the Settings window.
Click on the button "Get From Manual Window" in the Settings window. The values in the Position Correction X-Y fields are changing being the result of the calibration.
Click on the OK button in the Settings window.
Close the Settings window.
Close the Manual Control window.
Click on the Drop button and remove the Test Card from the Microscope.
The code position adjustment is done.
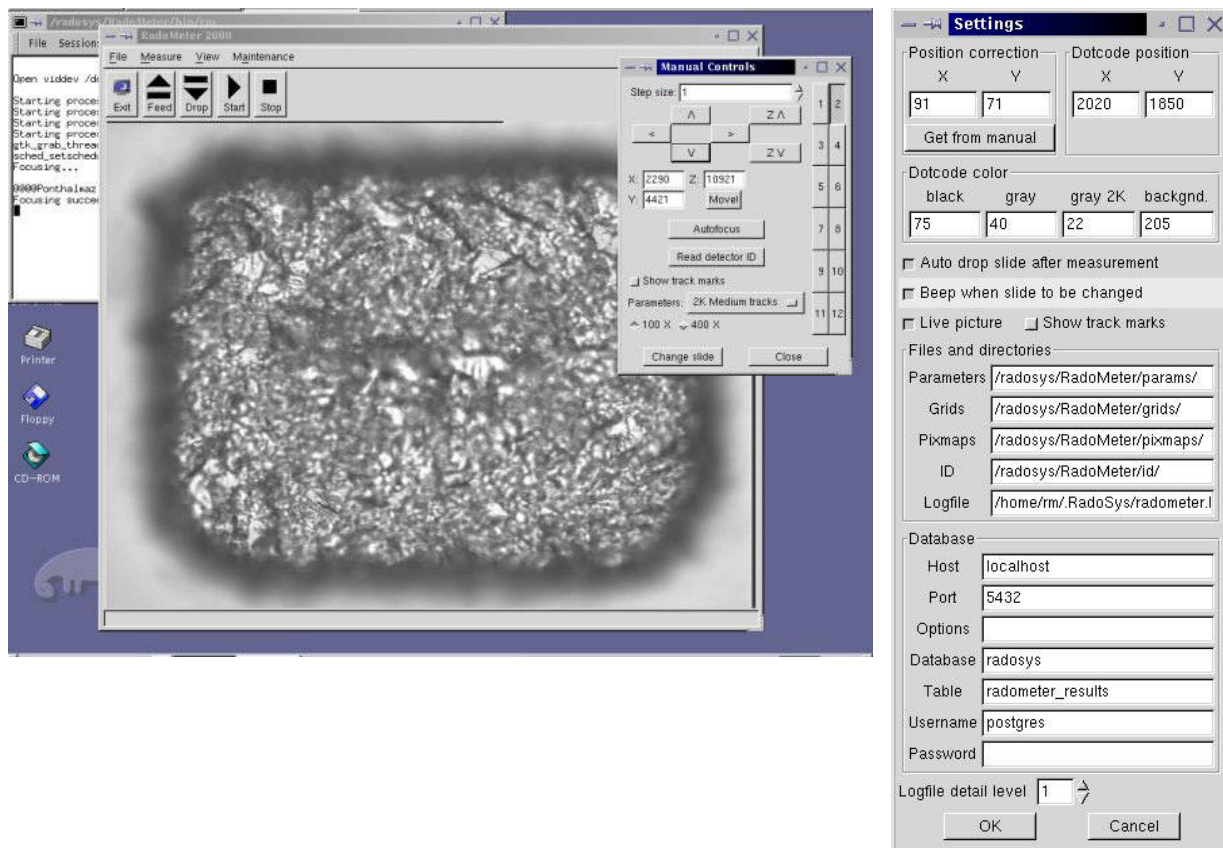
9.4 TRAY INNER SECTION LUBRICATION

This maintenance step is needed just after a prolonged and regular usage of the Microscope. Do not care of this requirement at the time of the first installation too much. However take it into account after processing 10 thousands of detectors.

9.5   REPLACEMENT OF THE BACKUP BATTERY (RADOSYS 2000 VERSION ONLY)

Remove the side wall of the computer by a sliding motion towards the direction of indicated by a big green arrow on the picture.ed to a new one, please do it according to the step-by-step instructions, as follows.

Switch the computer off. Remove all of the connecting cables. Place the computer to the desk by its side. Proper orientation and position is displayed on the image below.
Remove two screws at the rear panel fixing the right most side wall of the computer case. The location of this screws are indicated by arrows in green on this picture.
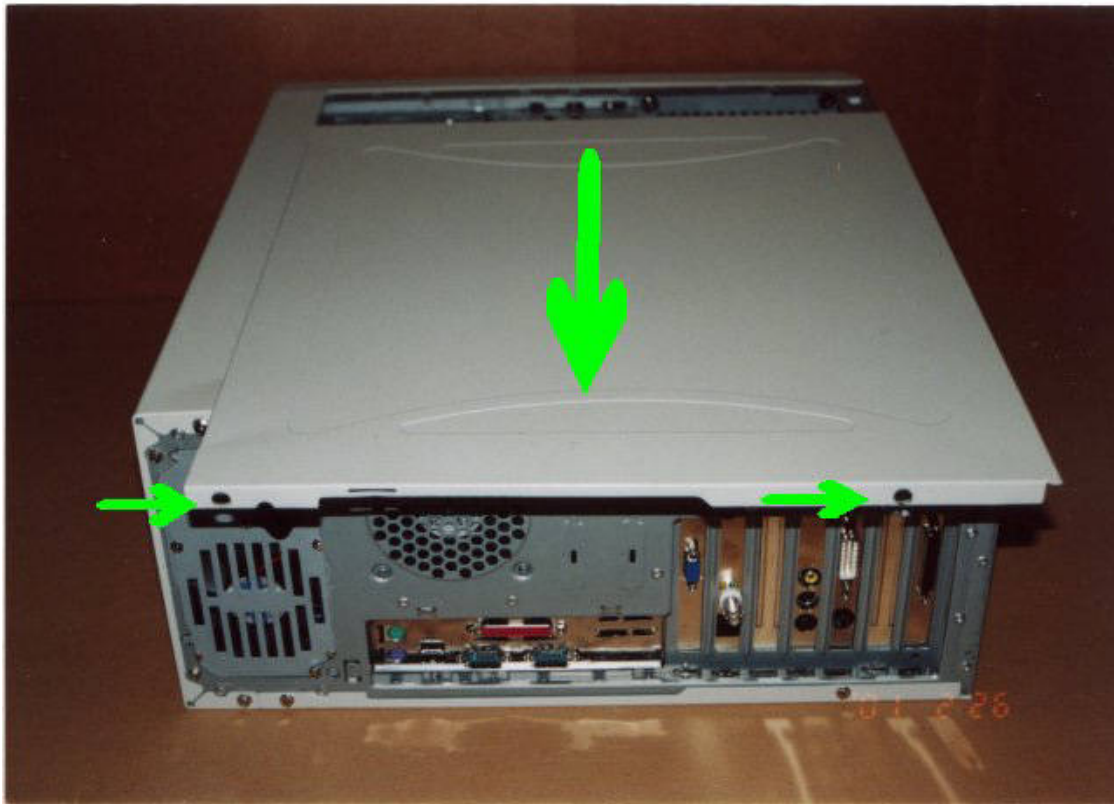
Locate the backup battery on the motherboard by means of the next picture.
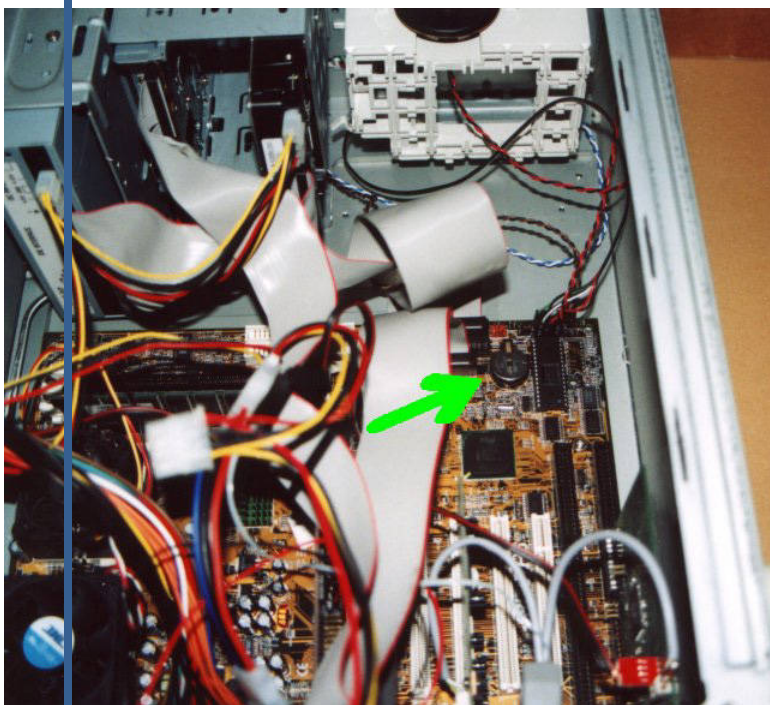
An enlarged picture helps to identify the location of this battery accurately.
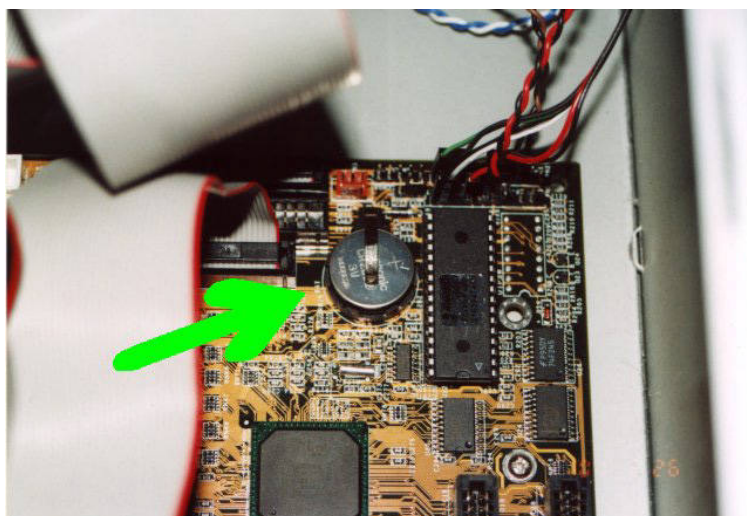
Remove the backup battery as it is suggested by the next picture.
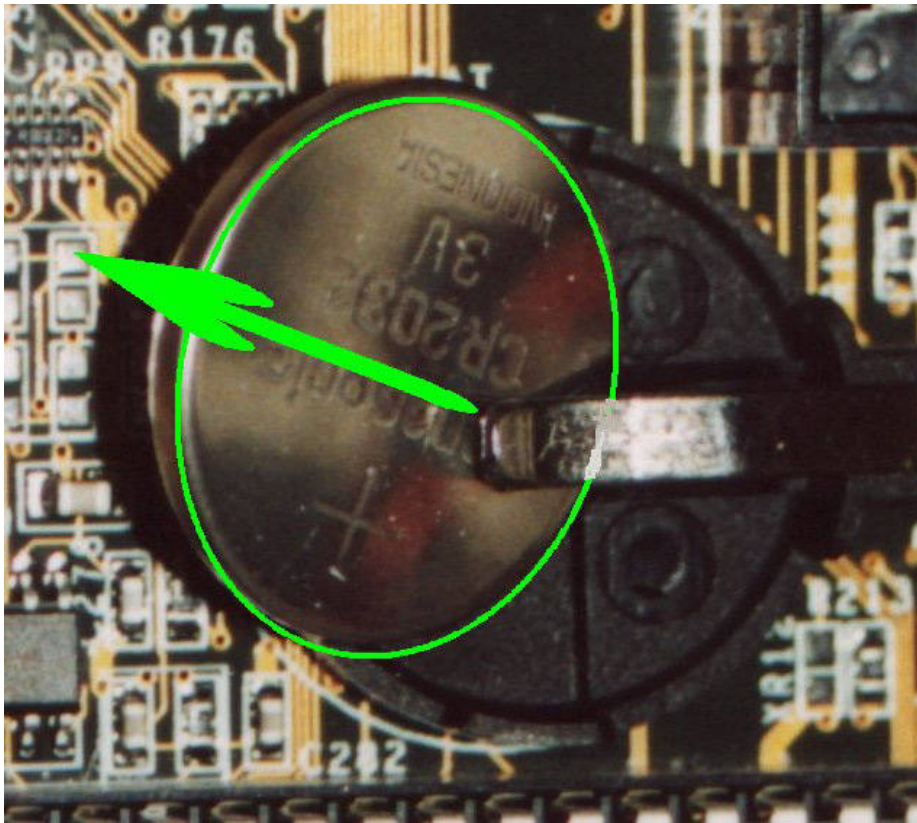
Place a new backup battery into the position of the older one, in order to replace it. Place the computer side wall to its original position and fixed it by the two fixing screws.

9.6 P

ACKING **RSV60** UNIT FOR TRANSPORTATION

9.6.1 PACKING ELEMENTS

Items using for packaging:

- *Metal box* with size of 750cmX550cmX380cm, including polystyrene foam bed assembly, which is fixed onto the bottom of the box.
- U-like polystyrene foam part to fix the microscope
- *Set of Cable Ties*, which is in the pouch mounted to the inner wall of the box
- *Shaped plastic sheet* to protect the metal door of the microscope against shacking damages
- A *roll of adhesive stripe* to fix the metal door of the microscope to the plastic dome.

Packaging instruction step-by-step

Step 1.
Be ensured that the plastic dome-like cover of the microscope is fixed to the main body of the microscope and the cover is firmly fastened by the rear hexagonal screw.

Step 2.
Place the Shaped Plastic Sheet between the metal door and the plastic dome, in order to protect the dome against shacking damages.

Step 3.
Fix the metal door to the dome by the Adhesive Stripe.
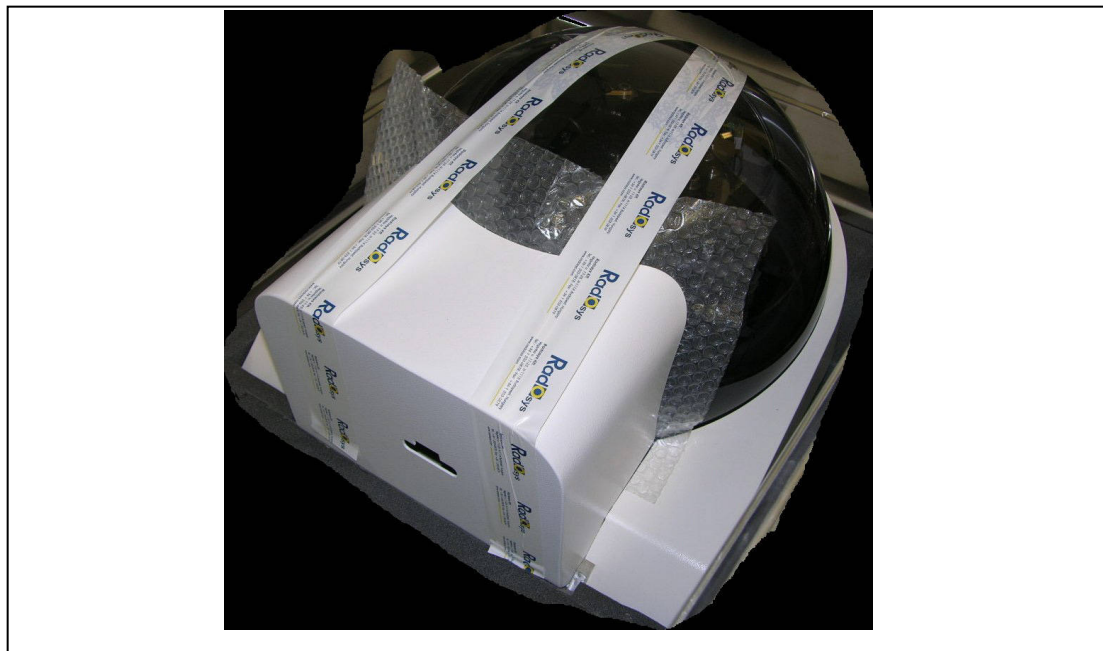
Step 4.
Place the microscope into the metal box. There is a polystyrene bed on the bottom of the box, which forms a nest for the microscope. Be sure that the whole body of the microscope is inside the nest correctly. The legs of the microscope should stand on the polystyrene floor of the nest firmly.
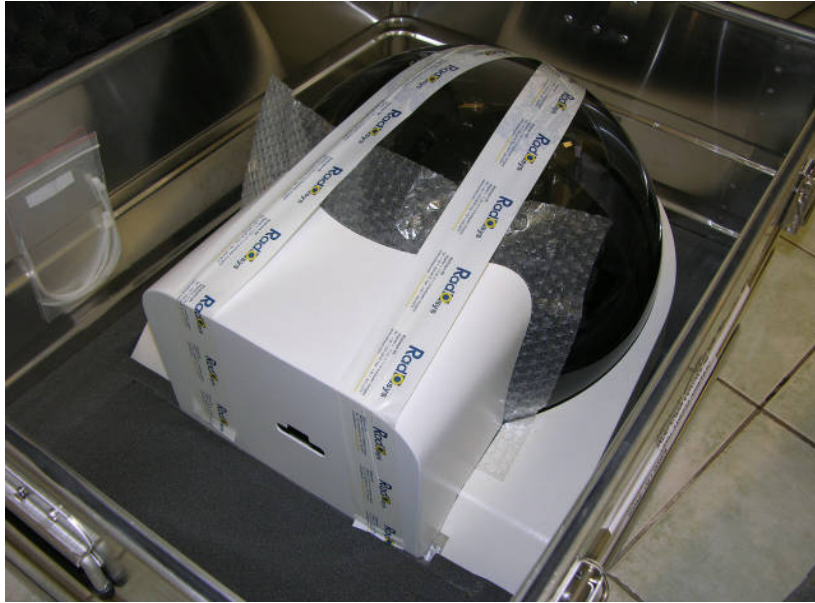
Check the correct positioning in the nest by checking the front, around the area of the metal door.

Step 5.
Place the U-like polystyrene part onto the microscope. The legs of the U-like polystyrene part should fit to the matching pit of the polystyrene base bed correctly. Otherwise the door of the metal box could not be closed.

Step 6.

Close the door of the metal box and lock it by the two locks on it.

There are holes on the locks using padlocks to secure. Instead of padlocks use the attached Set of Cable Ties to secure the locks.

Step 7.

Now the box with the microscope inside is ready for transportation.

Chapter 9. _____ **Maintenance and Troubleshooting**

10 Glossary

11 Picture Gallery

12 System Specification

Technical Specification of RADOSYS® System

Throughput of the system: 1000 dosimeters per week or more

Detector specification:
      Radiation sensitive component
            Type: PADC/CR-39 radon and thoron sensitive plastic material
Typical background/transit track density value: 0.1 tracks per mm2
Dimension: 10x10x1mm
Extra feature: Double ID code, for both visual and automatic reading
Note 1.: This type of CR-39 chip is compatible with the Radosys system only
Note 2.: The CR-39 chips supplied to the N-DOSYS product line are not compatible with the radon line.
      Radon Detectors:
All Types of Diffusion Chambers are Made of Conductive Plastics
All Types are delivered with Accurate Calibration Information
All types are delivered with Quality Control Sheet

RSFS standard type: for indoor radon tests:
           Individually Sealed into Radon-Proof Pouch
           Tamper-Proof Design
           Applicable for Both Long-term (80 Days) and Short-term (10 Days) Tests
           Metrology Information: Range of Detection from 40 to 12000 kBqh/m3
RSFV special type:
           Subtype of RSFS
           Double Chamber Technology
           Dedicated to Tests in environment with Unpredictable level of radon activity
           Metrology Information: Range of Detection from 40 to 100000 kBqh/m3
RSFW special type:
           Subtype of RSFV
           Equipped with Water/Humidity Protection
           Dedicated to Test in Humide envirtonment, for instance in Spa, Cave, Mine or Soil
RADUET special type:
           Radon-Thoron Discriminating Detector
           Unique, Double-Detector Structure, according to NIRS, Japan & Radosys Recommendation
           Dedicated to Thoron survey projects; a highlighted issue since 2005, WHO's Intnl Radon Project
RSFK special type:
           Dedicated to Regional Radon Mapping Projects. This type is available by individual contracts only.
Other available options: Custom-designed labels
      Ready-made, assembled dosimeters

Detector Development Process:

     Etching Unit (RB4):

     Type of developed tracks: Circular tracks primarily

     Etching substance: 25% / 6.25 molar sodium-hydroxide solution

     Etching temperature: 90 centigrade, factory default setting

     Etching time: 4.5 hours, factory default

     Number of detectors developed at the same time: 432

     Etching solution volume: 5000 g

     Bath operation specialties: Temperature regulation, automatic liquid stirring

     Other standard features: Set of accessory items for solution handling

     Control features: Advanced programmable options by front-panel keyboard

     Front Panel LCD Display with process information and temperature data

     Regional Power Versions: EU 220/240 VAC or USA/JAPAN 90/120 VAC; 50/60Hz

     Packaged weigh: 15 kg

     Dimension: 400x400x600mm

Evaluation process (RM Track Analysis Equipment):

     Microscope Unit:

         Imaging component: B&W CCD Camera

         Optical magnification: 100x

         Object movement: Automatic XYZ directional movement

         Extra feature: Automatic image focusing

         Feeding capacity: 12 detectors at RSV6 Version

                240 detectors at RSV60 Versionl

         Packaged weight: 35kg at RSV6 Version

                45kg at RSV60 Version

         Dimension without package: 500mm x 500mm x 300mm at RSV6 Version

                500mm x 800mm x 300mm at RSV60 Version

     Computer Unit:

         Architecture: Notebook HP-NX6110 or equivalent type

         Operational software environment: LINUX

         Power: 90 to 240 VAC   50/60Hz

         Packaged weight: 8kg

         Dimension without package: 100mm x 250mm x 300mm

     Operational Characteristics:

         Evaluation time per detector:

             In fast mode optimized for productivity: 45 sec

             In slow mode optimized for accuracy: 90 sec

         Track recognition capability: Single and double/triple overlapping tracks

         Area of detector scanned for track analysis: 50 mm^2

         Data report displayed: Chart of track density

         ID code recognition: Automatic dot code reading

         Data access: By advanced data-base operation

     Software options:

Chapter 12.   **System Specification**

Double OS configuration – Linux and Windows XP
Option 1. – Data exchange through extra HD partition
Option 2. - WMWARE assisted configuration with   both Linux and
Windows XP

13 Product History and Version Information

13.1 RB4 ETCHING UNIT

13.1.1 OPERATION WITH RB4-FW1 FIRMWARE VERSION

This is an outdated Chapter, since most of the earlier RB4 units had been already upgraded to firmware version FW3. But we kept this chapter in the User's Manual for those users, who still owns an RB4 unit with FW1 firmware version.

Units with S/N. RB4-101, -102 and -103 were supplied with firmware version RB4-FW1. The operation for these, 1st generation, units is documented in this chapter.

Note: The firmware of these units can be also upgraded, but the way of upgrading differs from the procedure described in Chapter 'Upgrading the Firmware of RB4 Unit'. In this respect please contact the manufacturer or the local vendor.

The firmware version FW1 was designed to providing as much simple operation than that of the former Radobath 99 unit.
Single button operation. The temperature regulator can be simply switched ON or OFF according to the action desired.
Only one, factory default target temperature, 90 centigrade is implemented. The target temperature is not selectable.

The main power switch locates at the left side wall of the equipment. Turn it to ON position to power up the unit. When the LCD display is illuminating, this indicates the power on status.

The temperature regulator can be controlled by the REGULATOR button of the front panel keyboard. Push this button to start heating the etching solution. Or push this button to stop heating.
The status of the regulator operation is indicated on the LCD display.

Note: Never switch on the regulator when the bath is empty. Switch it on only if the bath is filled up by liquid. When this rule was failed the heater might cause damages on the surface of the stainless steel pot.

Once the heater is on, the temperature regulator heats the liquid up to 90 centigrade and keeps the temperature at this value with tolerance of +/-1.5 centigrade.
The front panel LED indicator indicates the status of the heater. When the LED indicator is ON the heater is also ON and vice versa.

During the heating up period, the heater and also the LED indicator are ON, until the target temperature reaches 90 centigrade.
During the period, when the regulator is keeping the temperature at the target value, the heater and the LED indicator are ON and OFF periodically.

Note: Three additional buttons, the SETTING buttons, are located on the front panel keyboard. These buttons has no any functions at the FW1 Firmware Version. But they have extended functions at the FW2 Firmware Version.

13.1.2 UPGRADING THE FIRMWARE OF THE RB4 TYPE ETCHING UNIT

Upgrading the firmware of the RB4 unit requires establishing cable connection between the RB4 unit and an external computer. An interface connector for this purpose is located at the rear wall of the RB4 unit. The interface cable and the upgrade software are supplied by the manufacturer.

14 Product Sales Codes versus Technical Codes. Comparison Chart.

15 User's Manual Version History

15.1 MAN_2K_71

This release was available from 4th March, 2001 and accompanied the product in unchanged form until 2006. Before 2001 many, continuously developing versions of the Manual were published; the details are not listed here.
The version Man_2K_71 covers the product versions Radosys2000 and Radobath'99. Between 2001 and 2006 the product information was updated by releasing a series of Application Notes, from RSAN-101 to RSAN-114.

15.2 RS-MAN61

First release was published at 2nd October, 2006.
This is a significantly updated version, therefore the update details are not listed here.
All the text of the former version Man_2K_71 has been built into this version.
The version covers all the product versions; Radosys2000, Radosys2003, RS-V6, RSV60, and the etching bath units Radobath'99, RSB4, also detector types RSFS, RSFV and RADUET. The outdated detector types are not covered; Radoset and RSE-series, since these products was no longer available at the time of publishing this version of the Manual.

15.3 RS-MAN62

First release was published at 12/12/2006.

Chapter 2.3. Raduet Type Detector
- New reference is added.
Chapter 15. User's Manual Version History
- The body text of this chapter has been added.
Chapter 5.5.4. Data Exportation to Other Application Software
- This is new chapter.
Chapter 4.7.3. Routine Operation with DMU-V6R Version Software
- This is new chapter.
Chapter 5.2. Root User Operation.
- The login name was corrected. More information was added.
Chapter 15. Literature
- This is new chapter.
Chapter 2.4. RSNS type dosimeter
- Structure image added.
Chapter 4.8. N-DOSYS, NEUTRON DOSIMETRY APPLICATION SPECIFIC PROCEDURE
- This is new chapter.
Chapter 7.9. SCIENTIFIC BACKGROUND OF THE N-DOSYS NEUTRON DOSIMETER APPLICATION
- This is new chapter.
Chapter 5.6.6. WHEN ID CODE READING FAILS – This is new chapter.

15.4 RS-MAN63

First release was published at 25/08/2007.

Chapter 2.5. RSKS Type Dosimeter
- This is new chapter

Chapter 7.9 SCIENTIFIC BACKGROUND OF THE N-DOSYS NEUTRON DOSIMETER APPLICATION
The content of this chapter have been removed from RS_Man63, because of its large file size. At printed or PDF version of this Manual this chapter is attached to the end of this document.

Chapter 7.2. Radosys Radon Detectors
Text for 7.2.1, 7.2.2 and 7.2.3 was added.

Chapter 5.7. Radosys Special Type Detectors
Text for 5.7.1, The Raduet Detector, was added.

15.5 RS-MAN81

Chapter 4.5 MICROSCOPE MODEL SPECIFIC OVERVIEW. MODEL RSV6 VERSUS RSV60
       Chapter Title Update
Chapter 4.6 VERSION OVERVIEW. MODEL RSV6 VERSUS RSV8 AND MODEL RSV60 VERSUS RSV80
       New Chapter
Chapter 4.8.3   How to remove slides from auto-feeder unit at case of slide stack failure
       New Chapter
Chapter 5.5.5   Calibration using the DMU-V6R software
       New Chapter
Chapter 5.7.2   Raduet Imprecision
       New Chapter
Chapter 7.11 ESTIMATION OF UNCERTAINTY OF RADON MEASUREMENTS WITH ALPHA TRACK DETECTORS – THEORETICAL APPROACH
       New Chapter
Chapter 9.6 PACKING RSV60 UNIT FOR TRANSPORTATION
       New Chapter

15.6 RS-MAN82

Chapter 4.7 VERSION OVERVIEW. MODEL RSV8 VERSUS RSV10 AND MODEL RSV80 VERSUS RSV100
       New Chapter
Chapter 4.7   VERSION OVERVIEW. MODEL RSV8 VERSUS RSV10 AND MODEL RSV80 VERSUS RSV100
       New Chapter

Chapter 15. _____**User's Manual Version History**

Chapter 5.5.5   CALIBRATION   USING   THE   DMU-V6R   SOFTWARE   BEFORE
OCTOBER, 2012.
    Introductory is added
Chapter 5.5.6   CALIBRATION   USING   THE   DMU-V6R   SOFTWARE   AFTER
OCTOBER, 2012.
    New Chapter
Chapter 2.1   RSFS TYPE DETECTORS
    Introductory is added
Chapter 4.8. ROUTINE OPERATION WITH THE RADOSYS RS-RM VERSION TRACK
ANALYSIS SW
    Introductory is added
Chapter 4.10   RSV10X MODELS SPECIFIC OPERATION
    New Chapter
Chapter 4.12   CALIBRATION DATA TABLE UPDATE
    New Chapter

16 Literature

This is a short list of printed papers and of information on the web for those, who intends to learn more about track-etch theory, technology or about general radon test/survey matters.

1. A good summary about general and/or radon related track-etch theory:
Nikezic, D., Yu, K.N., "Formation and Growth of Tracks in Nuclear Track Materials", 2004, Materials Science and Engineering R, 46 (3-5), 51-123.

2. An excellent book:
Durrani, S.A., Ilic, R., 1997. Radon Measurements by Etched Track Detectors. World Scientific Publishing Co. Pte. Ltd., Chapter 2.1.4., 88-89.

3. A whole list of European country-wide radon surveys is available at this web-site, as well as the reports themselves:
http://radonmapping.jrc.it

4. A complete radon map of the United States is available at the web-site:
www.epa.gov